Type D personality across general population and coronary patient samples in Iceland

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TYPE D PERSONALITY ACROSS GENERAL POPULATION AND CORONARY PATIENT SAMPLES IN ICELAND: IMPLICATIONS FOR CARDIOVASCULAR HEALTH

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TYPE D PERSONALITY ACROSS GENERAL POPULATION AND CORONARY PATIENT SAMPLES IN ICELAND: IMPLICATIONS FOR CARDIOVASCULAR HEALTH

Proefschrift

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door

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FOREWORDS

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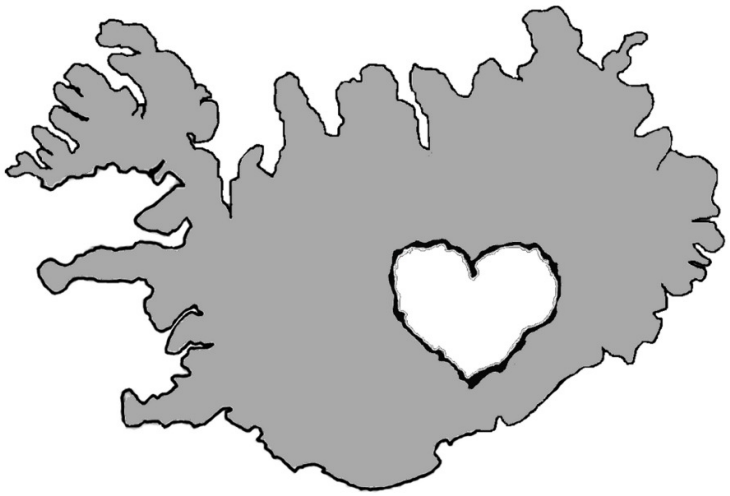
CHAPTER 1 | INTRODUCTION



Cardiovascular disease (CVD) is the leading cause of mortality in the world today, responsible for over 17 million deaths worldwide every year[1]. Coronary Artery Disease (CAD) alone accounts for nearly half of all CVD deaths, causing nearly two million deaths each year in Europe[2] and 7.2 million deaths worldwide[3]. In Iceland, around 1 in 4 annual deaths are due to CAD[4].

In CAD, the coronary arteries surrounding the heart become narrow due to a gradual built-up of fatty material (atheroma) in the artery walls over many years, resulting in plaque buildup and eventual damage to the endothelium. If a coronary artery becomes fully blocked due to rupture of this plaque and the subsequent formation of thrombosis, then the heart muscle may not receive sufficient blood perfusion, resulting in a myocardial infarction, commonly known as a heart attack[5-7]. Damage occurring to the heart muscle during a heart attack is irreversible, leading to the development of fibrotic scar tissue and stiffness in the heart muscle. The quantity of heart muscle damage and the location of the damage determines how badly affected the pump function of the heart is, ranging from weakened pump function to fatal failures in the hearts ability to function[8]. The presence of CAD is usually diagnosed by means of an invasive coronary angiography[9]. The medical treatment of CAD involves re-establishing blood perfusion from the coronary arteries to the heart by Percutaneous Coronary Intervention, where blockages in the arteries are re-opened, or by Coronary Artery Bypass Surgery, where new arteries are surgically implemented to bypass an occluded part of a coronary artery[10].

RISK FACTORS FOR CAD

CAD can develop without clinical symptoms over many years. The first presentation of CAD may sometimes be by heart attack and even sudden death without previously known disease[11]. An important part of the fight against CAD is based on primary prevention, namely attempts to delay or prevent progression of the damage to the coronary artery wall and hinder a first CAD-related event. As such, primary prevention has proven effective in decreasing mortality rates due to CAD[12,13]. Advances in medical treatment have also contributed to an increase in the number of patients with CAD surviving,

necessitating effective secondary prevention to reduce the risk of further CAD-related events in these patients[14].

In both primary and secondary prevention the fundamental battle is the same: to reduce the risk of (initial or recurring) CAD-related events by predicting people's risk of developing CAD, and helping individuals reduce that risk through management of risk factors known to influence the development and prognosis of CAD. Overall, hypertension, high cholesterol, smoking and diabetes have been established as the most important modifiable risk factors for CAD[15]. Studies have also emphasized the risk associated with physical inactivity[16,17], obesity[17-19], and unhealthy diet[20]. Non-modifiable risk factors for CAD include age, male gender, a family history of CAD and ethnicity (black and south Asian populations)[21]. The risk factors for CAD are largely similar in men and women[22], but clinical presentation of CAD and treatment administered can vary greatly by gender[22,23].

Managing CAD risk factors is not only important in individuals at high risk or patients with established CAD, but also in the general population, where there is a vast need for improved cardiovascular health[24]. Efforts to counter the CAD epidemic have identified four behavioral risk factors (non-smoking, body mass index < 25, sufficient physical activity, and healthy diet) and three biological risk factors (hypertension, cholesterol, and diabetes) as essential factors for achieving ideal cardiovascular health[25].

ASSOCIATION OF PSYCHOLOGICAL FACTORS WITH RISK OF CAD

In addition to biological and behavioral risk factors for CAD, psychological factors have received increased recognition as important risk factors for CAD[26,27]. Epidemiological investigations have demonstrated that psychological factors can promote the development and clinical manifestation of CAD[28-31]. Pertinent psychological factors include anxiety[32,33], depression[34-36], stress[37], and lack of social support[38]. Psychological factors tend to cluster, which again has been associated with an increased risk of CAD-related events[26,39]. The importance of considering psychological factors is increased further still by the fact that these factors can act as barriers for treatment adherence in patients with established CAD. They can also hinder effective modification of lifestyle-related risk factors, such as smoking, lack of physical activity, and an unhealthy diet[30].

The potential practical use of identifying psychological factors in risk assessments of CAD and prevention is substantial[40], but deciding how to use them is more problematic. Instead of looking at one psychological factor at a time (i.e. negative affect measure), as previous researchers have tended to do[41], it may be more practical to focus on combined factors that reflect a 'general negative affect'. An integrated approach of this type is possible with the use of personality factors. Personality factors (or traits) are factors that are stable over time and influence both the behavior of individuals in different situations[42] and their psychological well-being[43]. Personality factors can thus affect how often people experience negative feelings such as sadness, anxiety and stress, which, again, have been linked with increased CAD risk. Moreover, personality factors could potentially incorporate the added risk associated with the clustering of psychological factors. Accordingly, personality factors containing general negative affect- such as the distressed (Type D) personality construct- could potentially be used in CAD risk predictions.

TYPE D PERSONALITY

The distressed (Type D) personality construct originates from clinical and research work on Belgian patients with CAD[44]. The construct focuses on how differences in individual coping styles may affect the emotional and physical health of patients with CAD[45], and how the interaction between different personality traits may affect prognosis[46]. Initially, cluster analyses and theoretical models were combined to examine why some patients suffered more morbidity or mortality compared to other patients[47]. This research showed that the combination of two distinct factors - negative affectivity (NA) and social inhibition (SI) - was related to worse prognosis in cardiac patients[46]. These two factors were combined into a single personality construct that was called Type D, or the distressed personality[47].

Type D personality refers to people who experience frequent negative emotions across time and situations (high NA), but tend to inhibit their emotions and behaviors in social situations (high SI)[48]. Individuals with Type D personality tend to interpret daily events in their lives in a more negative way, leaving them with various negative feelings

they do not reveal or discuss these feelings with others due to their insecurity in social situations and fear of disapproval and negative reactions from others[49]. A 14-item questionnaire, known as the Type D scale (DS14), has been designed to measure Type D personality in a quick and reliable manner. The scale contains seven items for each subscale, with NA items assessing worry, irritability and dysphoria, and SI items measuring reticence, discomfort in social interaction and lack of social poise[49]. The original DS14 scale has good psychometric properties (Cronbach's alpha= 0.86-0.88 and test-retest reliability r= 0.72-0.82, for NA and SI respectively), and is a suitable instrument for identifying individuals with a Type D personality[50]. The DS14 scale has been translated and evaluated psychometrically in various countries (i.e.[51-54]) with a good level of success. Type D personality is a stable personality construct[55] that is highly prevalent[56]. Its prevalence ranges from 19-44% in coronary patients from various countries[57] and from 17-39% in the general population[58]. However, less attention has been paid to examining the validity of the construct itself[59,60], especially the construct validity of the SI subcomponent[60], and how NA and SI relate to other established personality traits[61,62].

ASSOCIATION OF TYPE D PERSONALITY WITH ADVERSE OUTCOMES IN PATIENTS WITH CAD

Type D personality has been associated with CAD morbidity and mortality in numerous studies. Evidence suggests that patients with a Type D personality are three times more likely to die from their CAD[63], and that this adverse prognosis is independent of other conventional risk factors, disease severity[48,63], appropriate medical treatment[64] and other psychological factors[64,65]. Type D personality has furthermore been associated with long-term psychological distress independent of baseline levels[63] and poor health status in patients[66].

Although there may be an overlap between the Type D personality construct and other psychological factors such as anxiety and depression, it does distinct itself from them as well. For example, studies have shown that depression and Type D personality represent two different kinds of emotional distress[67], and that Type D personality predicts depression and anxiety independent of baseline depression levels[63]. This indicates that Type D has something extra that is not included in other psychological factors, and that its

effects may be mediated through other pathways – for example the SI factor, which has been shown to modulate the effect of negative emotions on cardiac prognosis[65].

Type D personality has reached some credential as a valid risk marker for poor prognosis in patients with CAD. For instance, it is included in the 2012 European Guidelines for Prevention of Cardiovascular Diseases, of the European Society of Cardiology[30]. However, previous research findings on Type D personality are somewhat limited. In particular, the majority of previous studies examining the association of Type D personality with CAD prognosis have been conducted in Dutch or Belgian patient samples. Thus, more geographically diverse studies on the Type D personality construct are essential[68]. It should also be noted that a large study in cardiac patients in Germany[69] did not find an association between Type D personality and adverse prognosis. Furthermore, it has recently been suggested that the association of Type D personality with adverse outcomes mainly applies to CAD, and not to heart-failure patients[70]. Little is also known about the role of Type D personality as an aetiological risk factor for the onset of CAD, with only two very recent studies linking Type D personality with incidence of cardiac events[71,72].

MEDIATING MECHANISMS

Little is known about the mechanism by which Type D personality is associated with adverse cardiac prognosis. However, mediating pathways are generally thought to reside in both biological and behavioral mechanisms[56]. Suggested biological pathways include elevated cortisol levels[73-75] and proinflammatory cytokines[76], while behavioral processes are thought to reside in negative health-related behaviors[77-79] and poor treatment adherence[80,81]. Less is known about potential mechanisms linking Type D personality with psychological distress. Initial evidence suggests that maladaptive coping styles may partly explain its adverse effect[52,82-84]. Further research is needed on the possible mechanisms behind the association of Type D personality with adverse prognosis and psychological distress. Improved knowledge in this domain could suggest potential intervention strategies to counter the apparent effects of Type D personality.

GENERAL AIM OF THESIS

The aim of this thesis was (1) to assess the validity of the Type D personality construct and its association with poor cardiovascular health in Icelandic patients with established CAD, and (2) to explore how Type D personality is related to cardiovascular health in the general Icelandic population.

OUTLINE OF THESIS

Part I. Type D personality and cardiovascular health in coronary patients in Iceland

The first part of this thesis focuses on the validity of the Type D personality construct and its association with poor cardiovascular health in Icelandic patients with CAD.

Chapter 2 reports on the psychometric properties of the Icelandic version of the DS14 in patients with CAD, and examines whether assessment of Type D personality is confounded by disease severity. The construct validity of Type D personality was assessed by examining how the Type D subcomponents, NA and SI, relate to similar personality constructs. Chapter 2 also includes an initial exploration of whether Type D personality is associated with health-related risk markers in these patients.

Chapter 3 investigates the association of Type D personality with the clinical profile of a large nationwide sample (N= 1427) of Icelandic patients with established CAD. Specifically, this chapter explores differences between Type D and non-Type D patients regarding the prevalence of CAD risk factors, disease severity, and treatment administered. The aim of this analysis is to get a clear picture of the overall differences between Type D and non-Type D patients and a better understanding of the possible mechanisms behind the association of Type D personality with adverse cardiovascular outcomes. Chapter 3 also explores possible gender-related differences in the clinical correlates of Type D personality in this sample.

Chapter 4 concentrates on the relationship between Type D personality and anxiety, depression and stress in 315 Icelandic coronary angiography patients, and assesses if this relationship is independent of indicators of disease severity. Chapter 4 also explores whether patients with Type D personality maintain fewer health-related behaviors four months post angiography, compared to non-Type D patients.

Chapter 5 focuses on the relationship between Type D personality and anxiety, depression and stress at 14-17 months post angiography in the same sample of coronary angiography patients as in *Chapter 4*. Critically, this chapter also examines the mediating role of coping style in this relationship, and explores differences in smoking cessation by Type D personality.

Part II: Type D personality and cardiovascular health in the general population in Iceland

The second part of this thesis focuses on how Type D personality is associated with cardiovascular health, and the risk of initial development of CAD, in the general population in Iceland.

Chapter 6 describes the assessment and prevalence of Type D personality in a sample of young healthy adults. The objective of this study is to test how the Type D personality construct fits within the framework of the Five-Factor Model of personality, and to confirm the presence of emotional inhibition within the SI subcomponent of Type D personality. Furthermore, the role of Type D personality as a potential marker of emotional distress in this sample of young healthy adults is assessed.

Chapter 7 focuses on the relationship between Type D personality and the risk of developing CAD in a random sample of N= 4483 individuals from the general Icelandic population. More specifically, it examines how Type D personality is associated with conventional and lifestyle-related CAD risk factors, estimated 10-year risk of developing CAD, and incidence of previous cardiac events. It also examines possible gender differences in the effects of Type D personality on cardiovascular health in the general Icelandic population.

GENERAL SUMMARY AND CONCLUSION

The final chapter, *Chapter 8,* summarizes the overall findings of the thesis and discusses how they compare to those of previous studies. Subsequently, the clinical implications and limitations of the thesis are considered, and ideas about future research directions presented.

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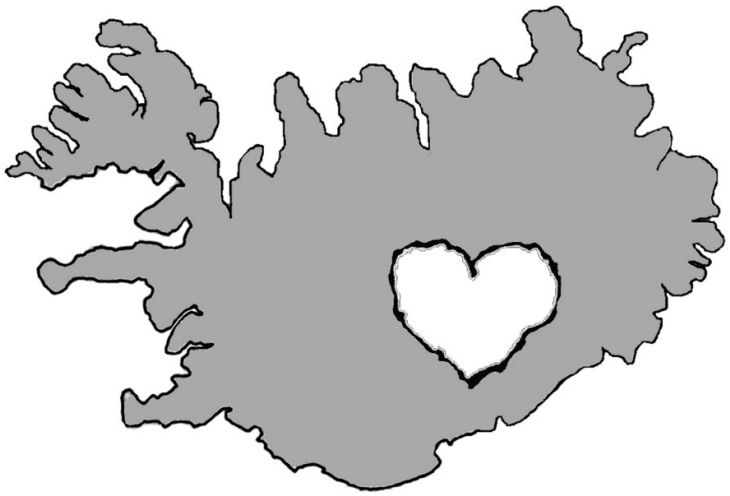
PART I | TYPE D PERSONALITY AND CARDIOVASCULAR HEALTH IN CORONARY PATIENTS IN ICELAND

CHAPTER 2 | VALIDITY OF TYPE D PERSONALITY IN ICELAND: ASSOCIATION WITH DISEASE SEVERITY AND RISK MARKERS IN CARDIAC PATIENTS



Svansdottir E, Karlsson HD, Gudnason T, Olason DT, Thorgilsson H, Sigtryggsdottir U, Sijbrands EJ, Pedersen SS, Denollet, J. Validity of Type D personality in Iceland: Association with disease severity and risk markers in cardiac patients. *J Behav Med* 2011; 35(2):155-166.

ABSTRACT

Background: Type D personality has been associated with poor prognosis in cardiac patients. This study investigated the validity of the Type D construct in Iceland and its association with disease severity and health-related risk markers in cardiac patients.
Method: A sample of 1452 cardiac patients completed the Type D scale (DS14), and a subgroup of 161 patients completed measurements for the Five-Factor Model of personality, emotional control, anxiety, depression, stress and lifestyle factors.
Results: The Icelandic DS14 had good psychometric properties and its construct validity was confirmed. Prevalence of Type D was 26-29%, and assessment of Type D personality was not confounded by severity of underlying coronary artery disease. Regarding risk markers, Type D patients reported more psychopharmacological medication use and smoking, but frequency of previous mental problems was similar across groups.
Conclusion: Type D is a valid personality construct in Iceland, and is associated with health-related risk markers, but not cardiac disease severity.

INTRODUCTION

Coronary heart disease is one of the leading causes of mortality in the world today[1,2], and although new cardiac treatments have helped fight coronary heart disease in recent years, an estimated 1/3 of coronary heart disease risk factors remain elusive[3]. The addition of psychological factors to standard biomedical risk factors may enhance the prediction of patients at risk. Initial research on the Type A behavior pattern suggested that psychological factors were related to increased risk of heart attacks, but further investigations on Type A behavior were inconclusive[4]. Subsequently, researchers turned their focus towards isolated factors such as hostility, depression, anxiety, social isolation, and chronic stress[4-7] to document a relationship between psychological factors and poor cardiac prognosis[6].

Clustering of psychological factors within individuals enhances the risk of adverse health outcomes[6,7], and this clustering may partly be attributed to a specific vulnerability in the realm of personality[8]. The distressed (Type D) personality construct was originally developed to identify cardiac patients who are vulnerable to emotional and interpersonal difficulties[9,10]. Type D individuals tend to experience negative emotions (elevated score on negative affectivity) while not discussing them with others due to fear of rejection (elevated score on social inhibition)[10]. Type D personality has been associated with poor quality of life and increased morbidity and mortality in cardiac patients[10-13]. The prevalence of Type D ranges from 28% to 32% across different cardiovascular conditions, including ischemic heart disease, chronic heart failure, and peripheral artery disease. The mortality risk incurred by Type D is three-fold, with this risk being independent of disease severity, such as left ventricular dysfunction, and mood states such as anxiety and depression, and despite appropriate medical treatment[12].

The mechanisms relating Type D personality with adverse prognosis in cardiac patients are generally not thought to derive from worse disease severity[14,15]. Rather, negative health-related behaviors, such as smoking and poor treatment adherence[16-18], and dynamic physiological processes such as elevated cortisol levels[19,20] and pro-inflammatory cytokines[21] have been suggested as possible contributing factors. Importantly, recent findings have casted doubt on the utility of using extent of coronary atherosclerosis as a surrogate means for inferring associations between psychological risk

factors and adverse cardiovascular outcomes in cross-sectional data[22]. In the present study, we included assessment of extent of coronary artery disease to rule out the possibility of reverse causation, whereby disease severity can contribute to greater psychological distress and, in turn, may confound the assessment of Type D personality traits.

In clinical and epidemiological research, Type D can be assessed with the standardized 14-item Type D Scale (DS14) that measures negative affectivity and social inhibition (seven items for each domain)[23]. The DS14 scale has been validated in Belgian[23], Chinese[24], Danish[25,26], Dutch[23], German[27], Italian[28] and Ukrainian[29] cardiac patients and healthy controls. However, only a few studies have examined how the Type D construct fits within the Five-Factor Model of personality, and no study to date has tested how the social inhibition factor relates to emotional control. Hence, the objectives of the current study were (a) to evaluate the psychometric properties of the DS14 in Icelandic cardiac patients with a specific focus on the construct validity of Type D, (b) to examine whether assessment of Type D personality is confounded by worse disease severity in these patients and (c) to explore the association between Type D and health-related risk markers.

METHOD

Participants

This study includes two cardiac patient samples. The first sample (cardiac sample I) consisted of 1291 patients hospitalized for coronary angiography and/or percutaneous coronary intervention at Landspitali-University Hospital in Reykjavik (May 2007-June 2008), the only hospital in Iceland where such operations are performed. These patients were approached when hospitalized to the coronary care unit, upon arrival to the emergency ward or by mail if they were on the waiting list for a coronary catheterization. Patients were eligible for participation only if they (a) underwent a coronary angiography or percutaneous coronary intervention during their current hospitalization; and (b) spoke and read Icelandic fluently. Forty-four patients were excluded because they either did not complete the DS14 (N= 34) or did not undergo coronary angiography (N= 10). The

remaining 1247 patients (875 men and 372 women) had a mean age of 64.8 years (SD 10.8), with women being significantly older than men (M= 63.3 (SD 11.0) vs. M= 68.2 (SD 9.5), t(1245)=7.57, p<0.001). This patient sample was included in the study to (a) estimate the factor structure of the DS14 scale, and (b) examine whether the assessment of Type D personality is confounded by the severity of underlying coronary artery disease.

The second sample (cardiac sample II) consisted of 161 patients from the coronary care unit, and from the heart failure clinic of the Landspitali-University Hospital (February-March 2006 and November 2006-April 2007). This sample was included in the study to examine more extensively the validity of the Type D personality construct in Iceland, and how it is related to health-related risk markers. To this end, these patients completed additional measurements that were not administered in the larger cardiac sample I. Four patients were excluded from analysis due to incomplete questionnaire data. The final sample included 157 participants (118 males and 39 females) with an average age of 61.7 years (SD 11.3), and again women tended to be older than men (M= 60.2 (SD 11.1) vs. M= 66.4 (SD 11.0), t(150)=3.03, p< 0.01).

Baseline characteristics for the two participant samples are presented in Table 1. Patients in cardiac sample I were older on average compared to patients in cardiac sample II ($t_{(1397)}$= 3.24; p≤ 0.001), but gender distribution was similar in the two samples ($\chi^2_{(1,N=1404)}$= 1.68, p= 0.20). The majority of patients in cardiac sample I had coronary artery disease (55%) or had experienced one or more heart attacks (23%), while patients with a history of one or more heart attacks (41%) and heart failure (24%) were more prominent in cardiac sample II.

The study protocol was approved by the medical ethics committee of the National Bioethics Committee in Iceland. The study was conducted to conform to the ethical tenets developed by the World Medical Association, as espoused in the Declaration of Helsinki. All patients provided written informed consent.

The DS14 scale

The DS14 is a 14-item questionnaire comprised of two seven-item subscales[23], measuring the tendency to (a) experience negative emotions (negative affectivity) and (b) inhibit

TABLE 1. Baseline characteristics.

	Cardiac sample I (N= 1247)	**Cardiac sample II** (N= 157)
Age (years) Mean (SD)	64.8 (10.8)	61.7 (11.3)
Gender		
Males	70% (875)	75% (118)
Heart disease		
Heart failure	2% (22)	24% (38)
Pacemaker and cardiac arrhythmia	7% (89)	11% (17)
≥1 heart attacks	23% (290)	41% (64)
Coronary artery disease	55% (678)	10% (16)
Hypertension	7% (92)	11% (17)
No disease	6% (73)	0 (0%)
Unknown	0.2% (3)	3% (5)

*Data are presented as percentages (N) unless otherwise specified.

self-expression in social interactions (social inhibition). The answering format is on a five-point Likert scale, ranging from 0 (*false*) to 4 (*true*), with total scores ranging from 0 to 28 for each subscale. Items include "*I am often irritated*" (negative affectivity) and "*I am a closed kind of person*" (social inhibition). The original Dutch DS14 was translated into Icelandic by four researchers. They received aid from two fluent Dutch speakers who independently translated the DS14 items from Dutch to Icelandic; a translation group examined the two independent translations, and one final version was constructed. Subsequently, the final Icelandic version was back-translated and compared to the original Dutch version to ensure accuracy. Participants were defined as having a Type D personality if they scored ≥ 10 on both negative affectivity and social inhibition. This cut-off value has been used in previous research[23,30], and is derived from the median split on negative affectivity and social inhibition scores of participants in those studies. A recent study using item-response theory has shown the cut-off ≥ 10 on both subscales to be the best to distinguish between Type D and non-Type D individuals, as all items had the highest measurement accuracy around that cut-off [30].

Construct validity

To evaluate the construct validity of the Icelandic DS14 scale, the NEO-Five-Factor Inventory (NEO-FFI)[31], Emotional Control Questionnaire (ECQ)[32,33], Hospital Anxiety and Depression Scale (HADS)[34] and Perceived Stress Scale (PSS)[35] were administered in Cardiac sample II.

The NEO-FFI is a 60-item self-report scale which assesses five broad personality traits from the Five-Factor Model of personality, that is neuroticism (e.g. anxiety, impulsiveness, vulnerability), extraversion (e.g. sociability, activity, positive emotions), openness (e.g. fantasy, feelings, artistic), agreeableness (e.g. trust, straightforwardness, altruism) and conscientiousness (e.g. achievement striving, dutifulness, self-discipline)[31]. The scale contains 12 statements for each trait, and respondents answer on a five-point Likert scale (ranging from *strongly disagree* (0) to *strongly agree* (4)) how each statement refers to them. The psychometric properties of the Icelandic version of the NEO-FFI are acceptable and the test-retest reliability and internal consistency deemed sufficient[36], with Cronbach's alpha ranging from 0.71 to 0.88 for the five traits[37].

The Emotional Control Questionnaire or ECQ measures how easily people express and control their emotions[32,33]. The scale includes 56 items which are divided into four factors (emotional inhibition, aggression control, benign control and rehearsal), but in this study a shorter 20-item version measuring rehearsal and emotional inhibition only was used[38]. Rehearsal refers to the tendency of individuals to ruminate over emotionally distressing events while emotional inhibition assesses to what extent people express their emotions. The response format for each item ranges from *strongly disagree* (1) to *strongly agree* (4). The Icelandic version of this scale has adequate psychometric properties with Cronbach's alpha reliability coefficients of $\alpha = 0.83$ for rehearsal and $\alpha = 0.74$ for emotional inhibition[39].

The HADS is a 14-item questionnaire that measures symptoms of depression and anxiety in physically ill people[34]. The questionnaire contains seven statements for each mood status. Participants rate on a four-point scale (0-3) how well each statement refers to them. Total scores range from 0 to 21 for each domain. The Icelandic version of the HADS identifies symptoms of depression and anxiety sufficiently well[40], with reliability estimates ranging from $\alpha = 0.78$-0.86 for anxiety and $\alpha = 0.65$-0.85 for depression[41].

The PSS or Perceived Stress Scale is a 14-item measure of self-appraised stress[35]. Items include for instance "*In the last month, how often have you felt that you were unable to control the important things in your life?"* The response format is on a five-point Likert scale ranging from *never* (0) to *very often* (4), and total scores range from 0 to 56. The scale has good psychometric properties[35,42] and correlates with social anxiety and depression symptoms[35]. The Icelandic version of PSS has comparable psychometric properties to the original language version[43] with Cronbach's alpha= 0.89 in a university student sample[37].

Disease severity

Disease severity, defined by how many coronary arteries were affected by coronary artery disease (i.e. normal arteries, 1, 2, or 3 arteries affected, and main stem narrowing) was derived from results of the coronary angiography in cardiac sample I. Angiography results were inconclusive for one person, which was excluded from this analysis. Information on disease classification, categorized as hypertension, coronary artery disease, previous heart attacks, pacemaker/arrhythmias and heart failure, was obtained from medical staff and/or retrieved from medical records. Information concerning disease classification was missing for three patients in cardiac sample I (0.2%) and five patients in cardiac sample II (3.2%).

Health-related risk markers

Participants in cardiac sample II provided information by self-report regarding certain health-related risk markers. These included (a) smoking status (*never, ex-smoker, current smoker*); (b) amount of smoking per day (*0-10 cigarettes, 10-20 cigarettes, 20-30 cigarettes, and > 30 cigarettes a day*); (c) duration of smoking (*0-5 years, 5-10 years, 10-20 years, > 20 years*); (d) previous mental problems, i.e. "*Have you experienced any significant mental problems in the past?*" (*no, yes*); and (e) psychopharmacological medication use, i.e. "*Have you used one or more of the following medications for more than two weeks in the past 12 months: sleeping pills, anxiety-reducing medications, antidepressants and sedatives?*" (*no, sleeping pills, anxiety-reducing medication, antidepressants, sedatives*). Of note, due to a low incidence rate for each medication

category, answers were recoded post-hoc to a binary variable containing the following distinction: *no, I have not used any of these medications; yes, I have used one or more of these medications*.

Statistical analysis

Principal axis factor analysis with direct oblimin rotation (delta= 0) was used to explore the factor structure of the DS14, using the scree plot and criterion of eigenvalues > 1 to determine the number of factors to extract. A confirmatory factor analysis of the scale was performed to confirm the two-factor structure of the scale, using Structural Equation Modeling (SEM) and the maximum likelihood method in AMOS 17 (Analysis of Moment Structures, Chicago, Illinois, USA). In the construction of the model, the theoretical foundation of the scale was taken into account. As the negative affectivity and social inhibition subscales each cover three different facets of negative affectivity and social inhibition, respectively, error covariance was added to items representing each facet, i.e. for items measuring the negative affectivity facets dysphoria (items 4, 7 and 13), worry (items 2 and 12) and irritability (items 5 and 9), and for items measuring the social inhibition facets discomfort in social interactions (6, 8 and 14), reticence (10 and 11) and social poise (items 1 and 3). Goodness of fit indexes used in the analysis included the Chi-square, the Comparative Fit Index (CFI) and the Root Mean Square Error of Approximation (RMSEA). For Chi-square, a value ≥ 0.05 indicates good fit (agreement with the null hypotheses that residuals are minimal and the data fit the model well). The Chi-square is influenced by sample size, which can lead to inflated Chi-square values and thus statistical significance, indicating bad fit[44]. For the CFI values close to 1 indicate a very good fit and values above 0.90 or close to 0.95 good fit. The RMSEA index should be ≤ 0.05 to indicate good fit, but levels ≤ 0.08 are considered to indicate adequate fit. Internal consistency of the scale was assessed with Mean inter-item total correlation and Cronbach's alpha.

Validity of the DS14 was estimated by exploring the Pearson's correlation between the negative affectivity and social inhibition subscales and similar constructs, i.e. neuroticism and extraversion, emotional inhibition and rehearsal, anxiety and depression and perceived stress. A factor analysis of scale scores on the DS14 scale, NEO-FFI, ECQ, HADS and PSS was executed to verify that (a) negative affectivity, neuroticism and

rehearsal, and (b) social inhibition, introversion and emotional inhibition measure related constructs, and to test how anxiety, depression and stress would relate to the negative affectivity and social inhibition factors. Differences in disease classification by Type D personality were assessed with Kendall's Tau-*c* calculations, but patients with arrhythmias and pacemakers were excluded from the analysis due to the different nature of their disease. The Kendall's Tau-*c* was also employed to estimate differences in disease severity by Type D personality in cardiac sample I, in both the entire sample and among patients who had established coronary artery disease. Finally, Type D and non-Type D patients in cardiac sample II were compared on smoking behavior, prevalence of previous mental problems, and medication use with Chi-square tests for nominal variables and Tau-*c* for ordinal variables. Association strength was estimated with Cohen's D calculations for quantitative variables and odds ratios for categorical variables. The SPSS 17 statistical software for Windows was used for all main analysis (Statistical Package for Social Sciences, Chicago, IL, USA).

RESULTS

Factor structure of the DS14

A principal axis factor analysis (direct oblimin rotation, delta= 0) in a combined sample of cardiac patients (N= 1404) indicated a two-factor solution, which explained 46% of variance in the patient sample. These two factors clearly reflected the negative affectivity and social inhibition subscales, with satisfactory factor loadings (ranging from 0.47-0.75) and good internal consistency (negative affectivity: Cronbach's alpha= 0.85 and Mean-inter-item correlation= 0.45; social inhibition: Cronbach's alpha= 0.84, Mean-inter-item-correlation= 0.43) (Table 2).

A confirmatory factor analysis of the two-factor structure of the Icelandic DS14 in the same sample indicated a good to adequate model fit for the unconstrained model (χ^2= 435.63, p≤ 0.001; CFI= 0.953 and RMSEA= 0.063, 90% CI:0.058-0.069). Standardized regression weights of items to factor ranged from 0.52 to 0.79 for negative affectivity and 0.44-0.80 for social inhibition (Figure 1).

TABLE 2. Factor analysis and reliability of the DS14 scale in a combined cardiac sample (N= 1404).

Factors	**I**	**II**
Negative affectivity items		
2. I often make a fuss about unimportant things	**0.61**	0.10
4. I often feel unhappy	**0.74**	0.07
5. I am often irritated	**0.73**	0.04
7. I take a gloomy view of things	**0.63**	-0.14
9. I am often in a bad mood	**0.58**	-0.13
12. I often worry about something	**0.60**	0.02
13. I am often down in the dumps	**0.73**	-0.12
Cronbach's alpha	**0.85**	
Mean inter-item total correlation	**0.45**	
Social inhibition items		
1. I make contact easily when I meet people	0.14	**0.72**
3. I often talk to strangers	0.16	**0.61**
6. I often feel inhibited in social interactions	0.29	**-0.50**
8. I find it hard to start a conversation	0.10	**-0.75**
10. I am a closed kind of person	0.12	**-0.66**
11. I would rather keep other people at a distance	0.16	**-0.47**
14. When socializing I don't find the right things to talk about	0.15	**-0.69**
Cronbach's alpha		**0.84**
Mean inter-item total correlation		**0.43**

Construct validity

The convergent and construct validity of the Icelandic DS14 scale was evaluated by examining correlations of negative affectivity and social inhibition with similar construct measurements in cardiac sample II. The negative affectivity subscale had a high positive correlation with neuroticism (r= 0.80) and rehearsal (r= 0.58), while social inhibition was negatively correlated with extraversion (r= -0.65) and positively with emotional inhibition (r= 0.50), which further supports the divergent validity of the Type D factors and their individual attributes. Negative affectivity had a high correlation with anxiety, depression

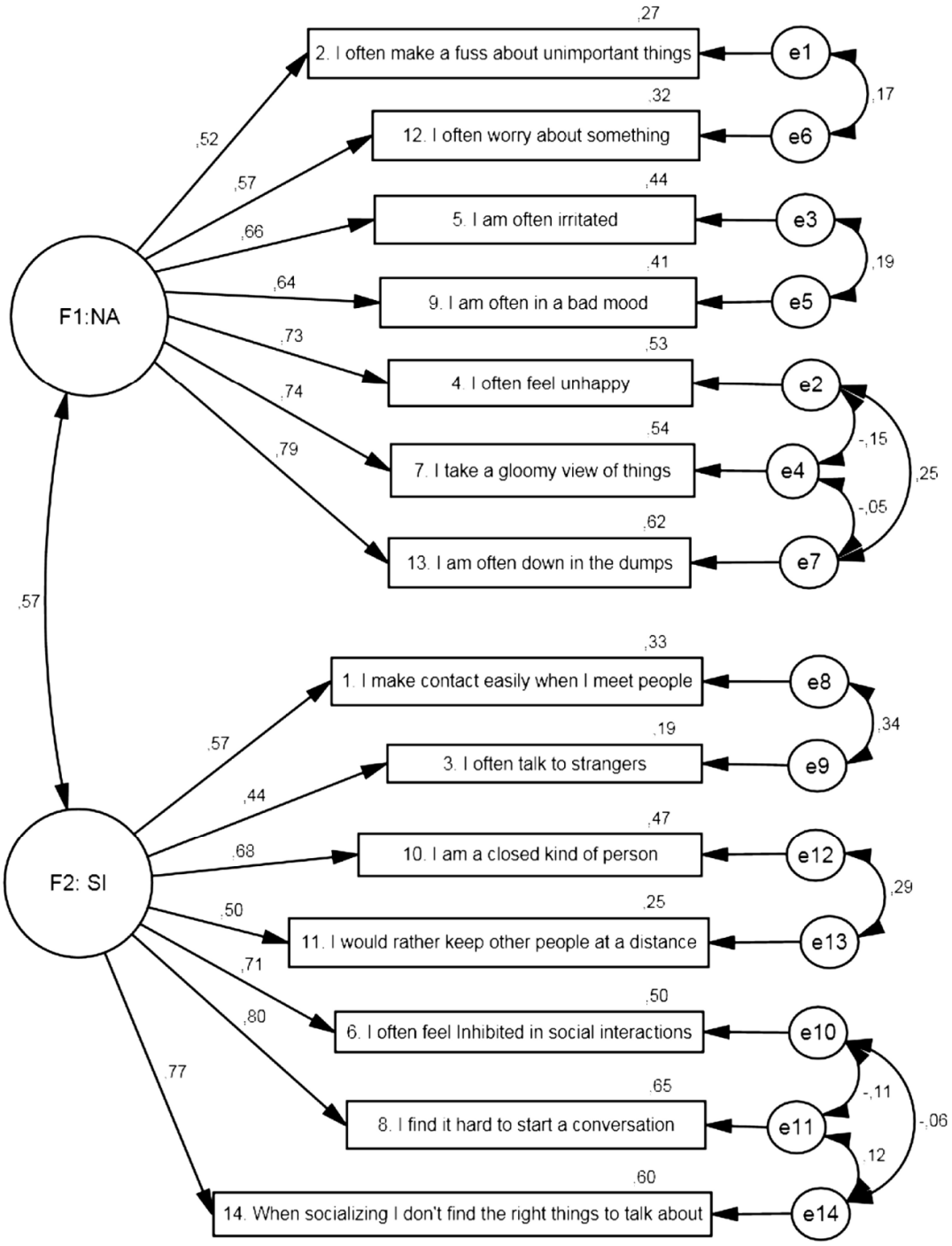


Figure 1. Standardized regression weights for the two-factor model of the DS14, representing negative affectivity (NA) and social inhibition (SI).

and stress scores, indicating that it clearly measures increased negative affect. An axis factor analysis (direct oblimin rotation, delta= 0) of scale scores confirmed that the negative affectivity and social inhibition subscales were differently related to the Five-Factor Model of personality; negative affectivity (loading= 0.79), neuroticism (0.78) and rehearsal (0.64) loaded on a single negative affectivity/neuroticism factor. Social inhibition (-0.95), extraversion (0.57) and emotional inhibition (-0.44) loaded together on a separate inhibition factor. Neither DS14 subscale was related to agreeableness, conscientiousness or openness of the Five-Factor Model of personality. Anxiety (-0.50), depression (-0.73) and stress (-0.60) loaded together on a single factor termed "psychological well-being", but anxiety also had a considerable loading on the negative affectivity/neuroticism factor (0.49) (Table 3).

Prevalence of Type D personality

Average scores on negative affectivity and social inhibition were equivalent in the two patient samples (negative affectivity: M= 8.6 (SD 5.6) vs. M= 8.8 (SD 5.9), $t_{(1402)}$= 0.46, p= 0.65; social inhibition: M= 9.3 (SD 5.8) vs. M= 9.3 (SD 6.1), $t_{(1402)}$= 0.11, p= 0.91; for cardiac sample I and II, respectively). Using the cut-off ≥ 10 for both subscales[23,30], 26% of patients in cardiac sample I and 29% of patients in cardiac sample II, were classified as Type D individuals.

Confounding effect of disease severity

Assessment of Type D personality was not confounded by severity of underlying coronary artery disease in cardiac sample I, as estimated by number of arteries affected by coronary artery disease from the coronary angiography results (Tau-*c*= 0.010, N= 1237, p= 0.72; Figure 2). About 1/3 of both non-Type D and Type D patients had normal arteries or atheroma with no significant occlusions, and with those individuals excluded from the analysis, Type D personality was still not associated with worse disease severity (Tau-*c*= -0.001, N= 838, p= 0.98).

Assessment of Type D personality was also not related to disease classification in cardiac sample I (Tau-*c*= -0.02, N= 1155, p= 0.45) nor cardiac sample II (Tau-*c*= -0.15, N= 135, p= 0.068). In both cases, disease classification was categorized as: no disease, hypertension, coronary artery disease, ≥ 1 heart attacks and heart failure.

TABLE 3. Correlations and results of a factor analysis of scale scores for the DS14, NEO-FFI, ECQ and HADS subscales and PSS scale[a].

Correlation			**Pattern matrix**				
Cardiac sample II (N= 157)	Negative Affectivity	Social Inhibition	**I**	**II**	**III**	**IV**	**V**
Negative affectivity	-----	0.47*	**0.79**	-0.14	-0.09	-0.07	0.04
Social Inhibition	-----	-----	0.11	**-0.95**	0.11	-0.05	0.05
Neuroticism	0.80*	0.47*	**0.78**	-0.12	-0.06	-0.14	-0.13
Extraversion	-0.48*	-0.65*	-0.09	**0.57**	0.12	-0.02	0.17
Agreeableness	-0.33*	-0.21*	-0.28	-0.03	0.07	-0.35	0.17
Conscientiousness	-0.20*	-0.25*	-0.01	0.06	0.05	0.12	**0.72**
Openness	-0.02	-0.07	-0.02	0.06	0.01	**-0.45**	-0.09
Rehearsal	0.58*	0.35*	**0.64**	-0.05	0.01	0.23	-0.02
Emotional inhibition	0.25*	0.50*	-0.08	**-0.44**	-0.19	0.25	-0.10
Anxiety	0.67*	0.26*	0.49	0.01	**-0.50**	-0.25	0.20
Depression	0.55*	0.35*	0.04	-0.15	**-0.73**	-0.11	-0.09
Perceived stress	0.38*	0.18*	0.04	0.05	**-0.60**	0.23	-0.09

The highest loadings on the corresponding factor are presented in bold.

[a]NEO-FFI: NEO-Five-Factor Inventory; ECQ: Emotional Control Questionnaire; HADS: Hospital Anxiety and Depression Scale; PSS: Perceived Stress Scale.

*p< 0.001.

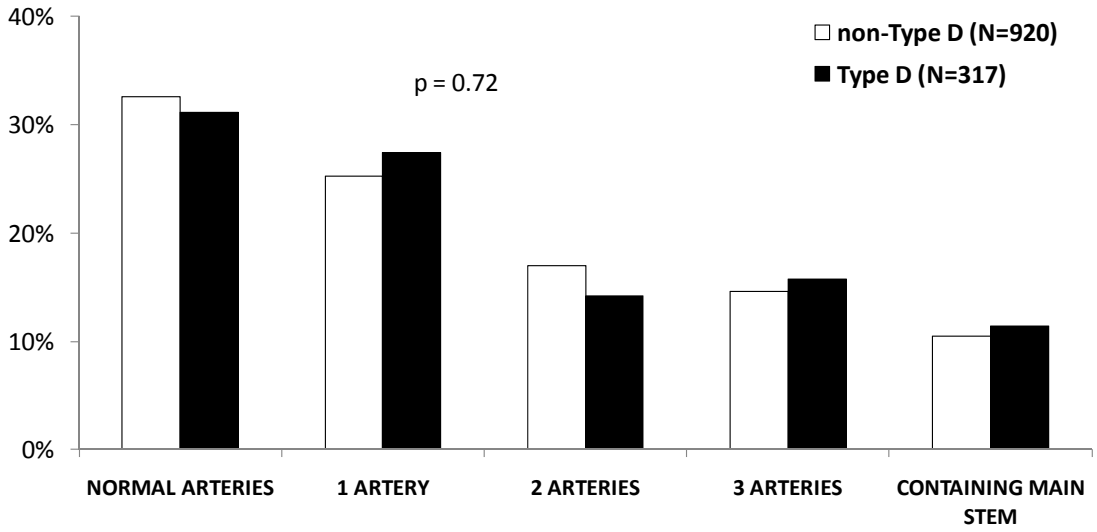


Figure 2. Coronary artery disease severity, stratified by Type D personality.

Association with health-related risk markers

As a final step, we explored the relationship of Type D personality with psychopharmacological medication use, previous mental problems and smoking in cardiac sample II. Type D patients reported more psychopharmacological medication use (Figure 3). When asked about use of sleeping pills, anxiety-reducing medications, antidepressants and sedatives, half of the cardiac patients with a Type D personality (51%) reported having used one or more of these medications compared to 29% of their non-Type D counterparts ($\chi^2_{(1,N=154)}$= 6.79, p= 0.009; OR 2.59, 95% CI:1.25-5.34, p= 0.010). Prevalence of previous mental problems did however not differ between Type D (19%) and non-Type D (14%) patients ($\chi^2_{(1, N=149)}$= 0.584, p= 0.45). Type D patients were significantly more likely to smoke as compared with non-Type D patients (Figure 3); i.e. 22% versus 6% ($\chi^2_{(1,N=156)}$= 8.35, p= 0.004; OR 4.25, 95% CI: 1.50-12.00, p= 0.006). In patients with a history of smoking, no differences were found between Type Ds and non-Type Ds regarding how many cigarettes they smoked per day (Tau-*c*= 0.11, N= 115, p= 0.26). However, a trend towards a longer history of smoking was noted in Type Ds (Tau-*c*= 0.15, N= 120; p= 0.056), but 76% of Type D smokers (former or current) reported having smoked for 20 years or more compared to 59% of non-Type D smokers.

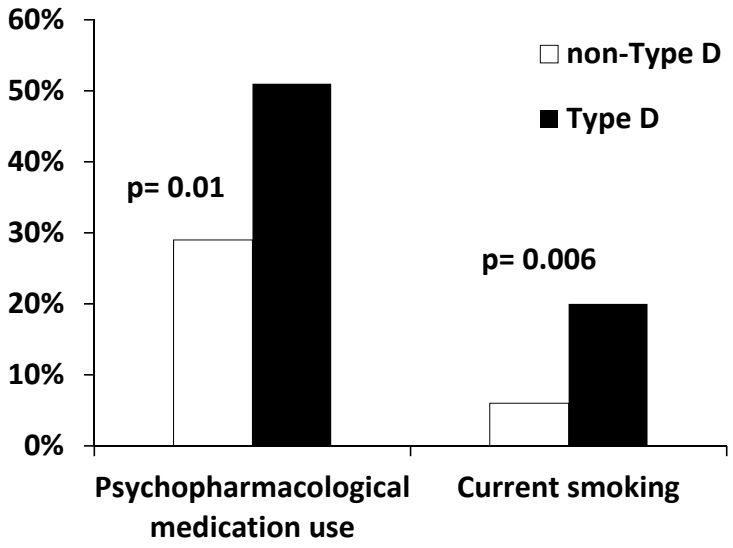


Figure 3. Prevalence of psychopharmacological medication use and smoking, stratified by Type D personality.

DISCUSSION

The objectives of the current study were to evaluate the psychometric properties and construct validity of the Icelandic DS14 scale, to test whether Type D assessment is confounded by disease severity in Icelandic angiography patients, and to explore the relationship between Type D and health-related risk markers. The findings supported the two-factor structure of the Icelandic DS14, and its validity and reliability in this sample of Icelandic heart patients. Principal axis factor analysis revealed internally consistent negative affectivity and social inhibition factors, and a confirmatory factor analysis confirmed the two-factor structure of the original scale[23] in a large sample of Icelandic cardiac patients.

The current results supported the convergent and divergent validity of the Type D construct in the Icelandic setting. An exploratory factor analysis of scale scores showed that negative affectivity, neuroticism and rehearsal loaded on the same factor, while social inhibition, extraversion, and emotional inhibition loaded together on another factor, supporting the construct validity of the two factors of the DS14[23,45] whilst also strengthening its cross-cultural validity. Furthermore, negative affectivity correlated

strongly with anxiety, depression and moderately with perceived stress, confirming the presence of increased negative mood states within the negative affectivity trait. In addition, social inhibition was clearly associated with emotional inhibition as measured by the emotional control scale. In a recent study, Grande et al.[46] advocated more testing of the construct validity of the social inhibition dimension, especially since it is the combination of social inhibition with negative affectivity that seems to make Type D personality a stronger predictor of adverse cardiac events compared with other single-dimensional negative affect factors, such as depression. In the context of Type D personality, the inhibition of emotions in social interaction is believed to play a key part in the association with adverse cardiac prognosis, by modulating the effect negative emotions have on cardiac prognosis[47]. Others have also linked social inhibition with social avoidance[24], lack of social boldness[46] and suppressed anger[48].

The prevalence of Type D personality of twenty-six and twenty-nine percent in the cardiac samples was comparable to that found in European and Chinese samples[23-29]. Assessment of Type D personality was not confounded by disease severity, as estimated by the number of coronary arteries affected with coronary artery disease and/or presence of significant narrowing at the main stem. This finding is in accordance with previous results in coronary artery disease and congestive heart failure patients, where no association has been found between Type D personality and indicators of disease severity, such as multi-vessel disease[49], left ventricular ejection fraction[15,50] and biomedical markers (i.e. brain natriuretic peptide)[51]. Similarly, Type D personality was not related to disease classification in either of the cardiac samples. The majority of former findings have generally also revealed that Type D personality is stable across time, and does not seem to be affected by changes in mood status or severity of cardiac disease[49].

The lack of association between Type D personality and extent of coronary artery disease does not necessarily diminish the status of Type D personality as a predictor for adverse cardiac prognosis. Conversely, these findings may merely indicate that the mechanisms relating Type D personality with adverse prognosis do not stem from worse disease severity, but through other pathways. Furthermore, if disease severity were in fact the pathway through which Type D personality affects cardiac prognosis, then the

association between Type D and prognosis should diminish in strength or disappear altogether when multivariable adjustments for disease severity markers are conducted. This has however not been the case in previous studies, as is evident in the recent review by Denollet, Schiffer et al.[52]. Mediating mechanisms linking Type D with adverse cardiac prognosis reside more likely in behavioral and physiological processes. Potential behavioral factors include unhealthy lifestyle behaviors[53], more smoking[18], poor treatment adherence[22,54] and inadequate consultation behavior[16], while physiological and biological processes may include elevated cortisol[19,20], pro-inflammatory cytokines[21] and cardiovascular stress reactivity[52] to name a few. Type D patients may thus be less likely to follow their doctors recommendations regarding medications or changing unhealthy lifestyle behaviors, and perhaps less efficient in presenting their symptoms to their doctor, due to their high social inhibition. Such factors could possibly explain why these patients develop or experience a more adverse prognosis compared to their non-Type D counterparts.

A recent study by Rozanski et al.[22] has also reported that psychological risk factors (depression, hostility, social support, perceived stress, job strain, and optimism) were not associated with the extent of coronary atherosclerosis. This further supports the lack of association between Type D and extent of coronary artery disease in the current study, as the Type D construct generally summarizes such psychological risk factors in the general negative emotional distress it encompasses[55]. Finally, even as some researchers have disputed that the relation of psychological factors with cardiovascular prognosis is confounded by worse somatic health, findings from a recent study have indicated that the Type D personality construct is less confounded by somatic health compared with depression[15].

Type D personality had strong ties to health-related risk markers in cardiac patients. Although no association was found between Type D personality and prevalence of reported previous mental problems in the current study, psychopharmacological medication use was higher among Type D patients compared to their non-Type D counterparts, and a high correlation emerged between negative affectivity and anxiety and depression. Previously, researchers have also found that post-myocardial infarction

patients with a Type D personality were significantly more likely to use benzodiazepines as compared to non-Type D patients[56]. The lack of association with former mental problems seems contradictory with the high correlation noted between negative affectivity and anxiety and depression. The assessment of previous mental problems may not adequately portray the number of previously diagnosed mental problems, due to the simplistic one question format assessment.

We also found a relationship between Type D personality and smoking among cardiac patients. Incidence of current smoking was higher in the Type D patient group, and there were some indications that Type D smokers had a longer history of smoking compared to non-Type D smokers. Previously, it has been reported that cardiac patients with a Type D personality may be more likely to smoke[57], and that Type D individuals are less likely to engage in healthy lifestyle behaviors[53]. These findings suggest that cardiac patients with Type D personality may struggle more with the lifestyle changes recommended by doctors to decrease likelihood of further cardiac events. In addition, previous results have indicated that heart failure patients with Type D personality are more likely to show inadequate consultation behavior compared to non-Type D patients[16,58], which implies that self-management and medical adherence in these patients may be impaired as well. Nevertheless, research results have indicated that the adverse effect of Type D on cardiac prognosis[57] and poor health status[18] remains significant despite statistical adjustment for smoking and other mechanisms that may mediate the relationship between Type D and health outcomes. More research needs to be conducted to clarify which mediating mechanisms are behind Type D's association with adverse prognosis in cardiac patients, and to determine whether health-behavior and/or poor medical adherence play a significant role.

Certain limitations restrict the interpretation of the present findings. First of all, the participant samples were not randomly selected. Yet, cardiac sample I included consecutive patients nationwide in Iceland, which diminished greatly the risk of selection bias in that sample. Another limitation is the self-report of psychopharmacological medication use, previous mental health problems and smoking, and the unavailability of these measures from cardiac sample I.

Overall, the results of the present study indicated that the Icelandic DS14 is a psychometrically sound assessment tool that can be readily applied in epidemiological and clinical research. The Type D personality construct was prevalent in Icelandic cardiac patients, not confounded by disease severity, and related to certain health-related risk markers in this clinical population.

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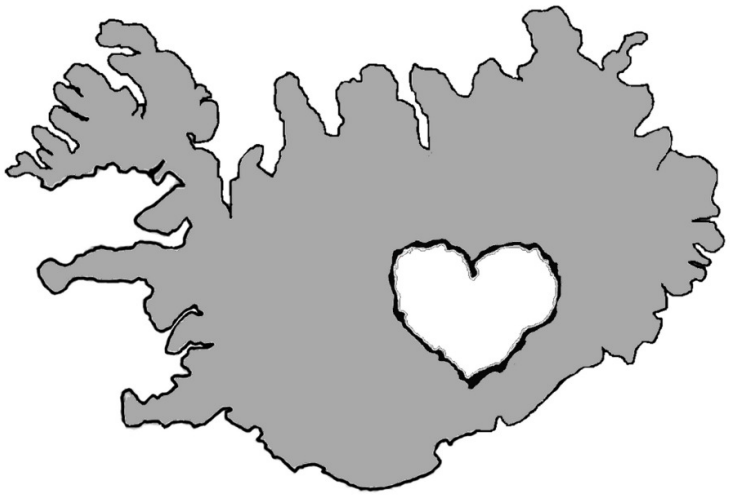
CHAPTER 3 | TYPE D PERSONALITY AND GENDER-RELATED DIFFERENCES IN THE CLINICAL PROFILE OF PATIENTS WITH CORONARY ARTERY DISEASE



Svansdottir E, van den Broek KC, Denollet J, Gudnason T, Karlsson HD. Type D personality and gender-related differences in the clinical profile of patients with coronary artery disease. Submitted.

ABSTRACT

Background: The distressed (Type D) personality has been associated with adverse cardiovascular outcomes, but the mechanisms behind this association are largely unknown. This study explored if Type D personality is associated with differences in the clinical profile of patients with coronary artery disease, concerning traditional risk factors, disease severity, and treatment, and examined possible gender disparities in these associations.

Methods: The study included a nationwide, unselected cohort of Icelandic patients (N= 1427, 78% men; mean= 64.5 ± 10.5 years) diagnosed with coronary artery disease by coronary angiography at Landspitali-University Hospital from May 10th 2007 to April 30th 2009. All participants completed the Type D scale (DS14). Demographics, risk factors, treatment, and disease severity (number of vessels affected and angina class) were registered in the Swedish Coronary Angiography and Angioplasty Registry.

Results: The prevalence of Type D personality was 24%. In a gender stratified analysis, Type D was associated with more smoking in men (31% of Type Ds vs. 23% in non-Type Ds, p= 0.002), and a similar trend was noted in women. Type D women were significantly younger than non-Type D women (by six years on average, p< 0.001) at the index angiography, they were more often subject to re-angiography (30% of Type D women vs. 20% of other patients, p< 0.05), and had a lower prevalence of hypertension treatment (60% vs. 73%, p< 0.05). No difference was found in other traditional risk factors, disease severity or treatment after the angiography.

Discussion: In this nationwide study, a striking gender disparity was found, as Type D personality was associated with a younger age at index coronary angiography, less medically treated hypertension and more re-angiographies in women, but not in men. Type D personality was associated with smoking, but not with other risk factors, disease severity or treatment. Type D women may be at risk for early disease onset and progression of coronary artery disease.

INTRODUCTION

Cardiovascular disease (CVD) is the most common cause of death worldwide[1]. Efforts to counter this epidemic have focused on adequate diagnosis, treatment, and prevention of CVD, including coronary artery disease (CAD)[2]. These efforts may, however, be hindered by psychological factors, which can impede treatment adherence and lifestyle improvements in CVD patients[3], and have been linked to an adverse prognosis[4,5]. One such factor is the distressed (Type D) personality profile. Type D personality consists of two stable personality traits, negative affectivity and social inhibition, and describes individuals who frequently experience diverse negative emotions, but tend to inhibit self-expression in social interaction[6]. Type D personality has been associated with a three-fold increase in morbidity and mortality risk in patients with CVD[7], but other studies have suggested that the adverse effect of Type D personality mainly resides in patients with CAD and not in patients with heart failure[8].

The mechanisms linking Type D personality with poor cardiovascular outcomes are largely unknown. Previous studies have indicated that Type D predicts poor outcomes independent of traditional risk factors and disease severity[9], while other studies have linked Type D personality with smoking[10,11] and other unhealthy lifestyle behaviors in cardiac patients[12]. In addition, Type D patients seem to maintain poor medication adherence[13], and inadequate consultation behavior[14,15]. Thus, it is possible that differences in the overall clinical profile and disease management of patients with Type D personality could contribute to their adverse prognosis.

Furthermore, it is well established that specific risk factors may differ by gender[16] and striking gender differences exist in presentation, symptoms, diagnosis, and treatment of CAD[17]. However, little is known about gender differences in the effect of Type D personality, whereas only two studies have investigated gender differences in relation to Type D personality, linking it with different risk factors by gender in general population samples[18,19].

The purpose of this study was to explore differences in the clinical profile of Type D and non-Type D patients with CAD regarding cardiovascular risk factors, disease severity, and treatment administered, and to explore possible gender-related differences in the clinical correlates of Type D personality.

CHAPTER 3

METHODS

Participants

The study included patients undergoing coronary angiography (CAG) and/or percutaneous coronary intervention (PCI) at Landspitali-University Hospital in Reykjavik. This hospital performs all CAG's and PCI's in Iceland. Participants were recruited from May 10th 2007 until April 30th 2009. The study protocol was approved by The National Bioethics Committee in Iceland, and was conducted according to the ethical tenets of the World Health Organization and the Declaration of Helsinki. All patients provided written informed consent.

During the two year study period, 3732 CAG and/or PCI's were performed on 3240 patients. Patients were eligible for participation provided that they (a) underwent a CAG or PCI during their current hospitalization; and (b) spoke and read Icelandic fluently. Participants were approached for participation in the study when hospitalized to the coronary care unit or upon arrival to the emergency ward. Participation consisted of filling out the study questionnaire measuring Type D personality. An overview of patient recruitment is presented in Figure 1.

In total, 77% (N= 2385) of 3116 eligible patients were offered participation. Of these, 88% (N= 2094) accepted the invitation. Thus, 67% of all eligible patients who underwent a CAG and/or PCI in Iceland during the two year study period were included. For the 23% (N=731) of eligible patient not included in the study, 17% (N=556) were not approached for participation, due to early discharge, periodic demanding, understaffed days, commencing of new staff or general administrative difficulties. Inclusion was initiated but not completed for the other 6% (N=175) of patients, due to the same reasons. No significant age or gender differences were found between patients who participated and those not offered participation. Of the included 2094 patients, 1484 were men (71%) and 610 women (29%).

In the current study, only patients with one or more significant coronary artery stenosis (≥ 50% diameter stenosis) were included in the analysis, to ensure presence and uniformity of CAD. Thus, 361/1484 men (24%) and 304/610 women (50%) with no significant stenosis, and two men with inconclusive results, were excluded from

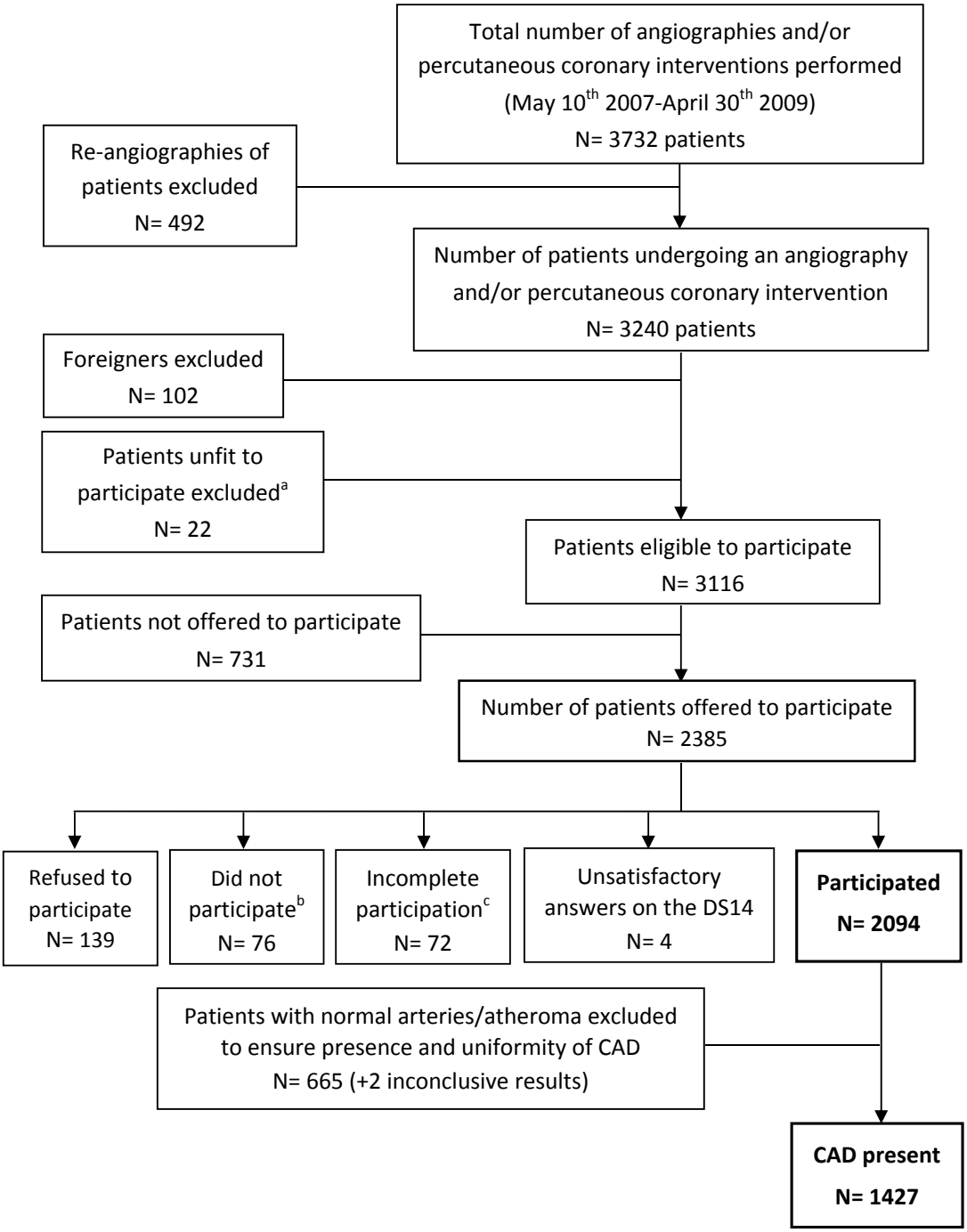


Figure 1. Recruitment of study participants.

[a]Patients with hearing problems, sight problems, clinically significant cognitive decline, or who are in a confused state or in no condition to participate at hospitalization;

[b]Patients which did not participate, but it is unknown whether they refused to participate or where not offered participation.

[c]DS14 scale missing (N= 47), unfilled (N= 8), or patients research papers missing (N= 17).

further analysis. The current patient sample included 1427 individuals with significant CAD; mean age 64.5 ± 10.5 years, 78% men (N= 1121).

Demographic variables

Data concerning age, gender, and residence were collected in the Icelandic part of the Swedish Coronary Angiography and Angioplasty Registry (SCAAR)[20], which is an online registry based in Uppsala in Sweden that stores and processes clinical information for patients undergoing CAG. Since January 1st 2007 Landspitali-University Hospital participates in SCAAR, and prospectively registers data on all CAG's and PCI's in Iceland into the registry. All data registrations are performed before, during, and immediately after the procedure by the performing physician or trained nursing staff in the angiography lab. Residency was defined by the postal code of the patient's address, and was divided into rural versus urban areas.

Type D personality

The Type D scale (DS14) is a 14-item self-report questionnaire measuring Type D personality. The DS14 contains two seven-item subscales, assessing "negative affectivity" (e.g. "*I often feel down in the dumps*") and "social inhibition" (e.g., "*I´m a closed kind of person*"). The answer format is on a five-point Likert scale ranging from *strongly disagree* (0) to *strongly agree* (4), with total scores on both subscales ranging from 0-28. Participants were defined as having Type D personality if they scored ≥ 10 on both subscales[21,22]. The Icelandic DS14 scale has good psychometric properties and internally consistent subscales (Cronbach's α= 0.85 for negative affectivity, α= 0.84 for social inhibition)[23].

Traditional risk factors and disease severity

All clinical variables were retrieved from SCAAR. Categorization for traditional CAD risk factors was as follows: (a) hypertension: current or previous medical treatment for hypertension (*no, yes*); (b) hyperlipidemia: current blood-lipid lowering treatment (*no, yes*); (c) smoking (*never, ex-smoker, current smoker*); and (d) diabetes (*no, yes-but not treated with insulin, yes-and treated with insulin*). Family history was not included in the

analysis of the traditional risk factors. The Body Mass Index (BMI) was calculated from weight and height.

Other clinical variables included previous history of CAD, disease severity indicators and treatment decision. Previous history of CAD was defined as having had: PCI, myocardial infarction (MI) and/or previous coronary artery bypass graft surgery (CABG). Measures of disease severity included the Canadian Cardiovascular Society Angina Grading Scale (CSS)[24] and results from the angiography regarding number of significantly stenosed coronary arteries, i.e. one, two, or three arteries, with or without a main stem stenosis. Indication of a more serious disease status was defined by a) CSS angina class ≥ III and b) ≥ three vessel disease and/or main stem stenosis. Registration of the treatment decision after the CAG included three categories representing different levels of treatment severity: (a) conservative treatment (no intervention, continue medical therapy); (b) revascularization (elective PCI, PCI ad hoc, CABG, CABG and heart valve operation); and (c) other treatment (further investigation, heart valve operation only, other alternative intervention). The "other treatment" group was excluded from analyses involving treatment decision, as it did not harmonize with the treatment severity ranking. We also explored whether patients had undergone: (a) only one angiography; or (b) > one angiographies during the study period.

Statistical analysis

All analysis were performed using the SPSS 17 statistical software (Statistical Package for Social Sciences, Chicago, IL, USA), with alpha ≤ 0.05 and two-tailed tests to indicate significant differences. The association of Type D personality with traditional CAD risk factors, disease severity, invasive treatment and re-angiographies were investigated with an independent t-test for continuous variables, Chi-square for nominal variables, and Tau-*c* for ordinal variables. Participants with missing values on specific variables were excluded from analysis involving those variables.

To examine differences in risk factors, disease status and treatment stratified by gender and Type D personality (i.e. differences between non-Type D men, Type D men, non-Type D women and Type D women) one-way ANOVA calculations were performed for continuous dependent variables and Chi-square calculations for nominal dependent

variables. Post-hoc comparisons were executed for all significant findings ($p< 0.05$) to determine the location of significant difference between the four groups, using Tukey's for continuous variables, but individual Chi-square comparisons for nominal variables for the following two group comparisons: (a) between non-Type D men and Type D men; (b) between non-Type D women and Type D women. Effect sizes were calculated for significant differences using Odds Ratios (OR) with 95% confidence intervals, estimated with binary logistic regression for categorical variables.

RESULTS

In total, 24% (N= 344) of CAD patients were categorized with Type D personality. Prevalence of Type D did not differ by gender (24% of men and 23% of women; $\chi^2_{(1, N= 1427)}= 0.32$; $p= 0.57$) or residency ($\chi^2_{(1,N= 1417)=} 1.23$; $p= 0.27$).

Type D personality, risk factors and CAD severity

In initial analyses without gender stratification, Type D personality was associated with a higher prevalence of current smoking, 30% vs. 23% ($p= 0.002$; OR 1.52, 95% CI: 1.16-1.99), but not with other traditional risk factors. Likewise, Type D personality was not associated with previous history of CAD, disease severity (consisting of multi-vessel/main stem disease and CCS angina class), or revascularization (Figure 2). A trend towards more re-angiographies in Type D patients was noted, as 24% of Type D patients versus 19% of non-Type D patients underwent more than one angiography during the two year study period ($p= 0.06$, OR 1.32, 95% CI: 0.99-1.76).

Interaction of gender and Type D personality

In a gender-stratified analysis, significant Type D related differences regarding CAD risk factors remained for smoking, while new differences were revealed for age, medically treated hypertension and re-angiographies. Subsequent post-hoc analyses were run to locate the nature of these differences, i.e. whether the effects of Type D personality differed across men and women. These analyses revealed that Type D women underwent the index CAG at a similar age as men and significantly younger than non-Type D women (by six years on average; 62.8 ± 9.3 vs. 69.0 ± 10.5, $p <0.001$; Figure 3). Conversely, no age

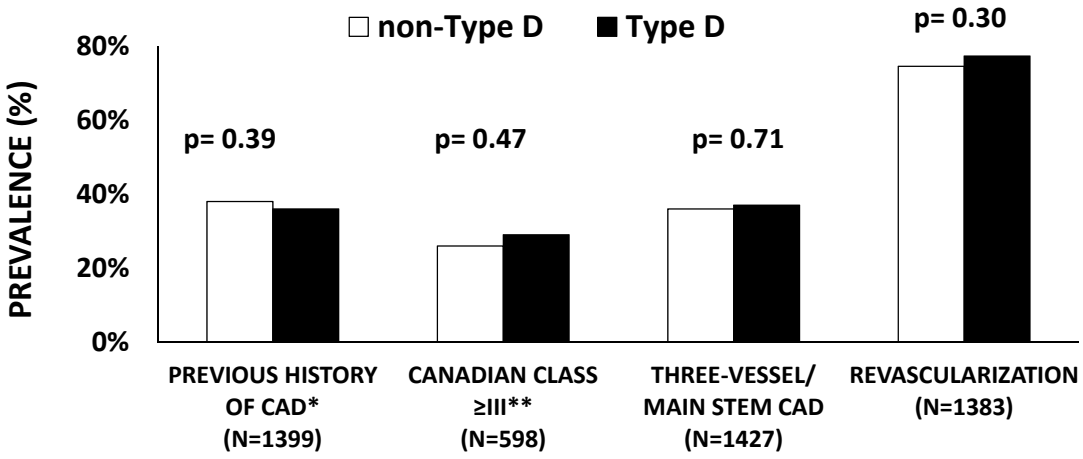


Figure 2. Prevalence of previous history of CAD, disease severity and revascularization by Type D personality.

*Previous myocardial infarction (MI), Percutaneous coronary intervention (PCI) or Coronary artery bypass surgery (CABG).

**Assessed only in patients with stable or unstable coronary artery disease (CAD) prior to angiography.

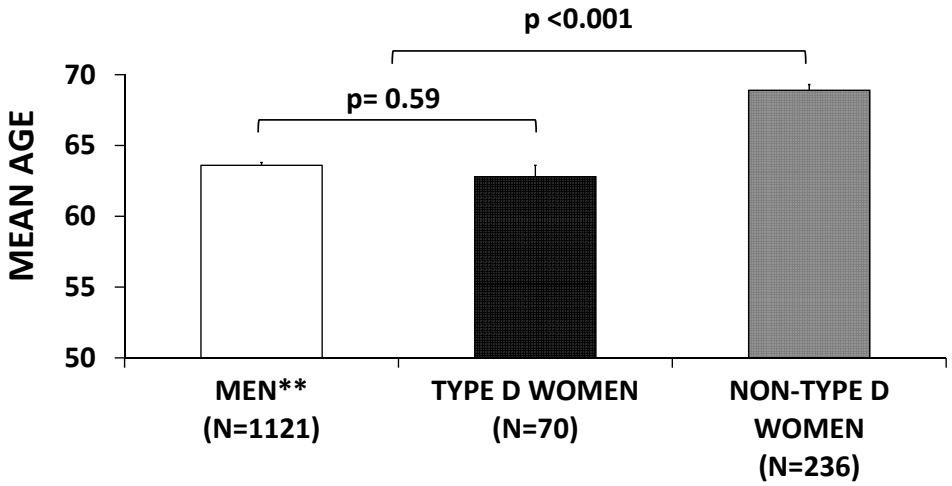


Figure 3. Average age of Type D and non-Type D women at CAD diagnosis compared to men.*

* Error bars represent standard errors.

**Type D and non-Type D men did not differ in age, and were pooled in one category.

differences were present between non-Type D and Type D men (M= 63.9 ± 10.5 vs. 62.8 ± 10.1, p= 0.12). Regarding other traditional risk factors (Table 1) differences in smoking associated with Type D personality were statistically significant in men (31% of Type Ds vs. 23% of non-Type Ds, p= 0.009; OR 1.50, 95% CI: 1.11-2.02). These figures were similar in the smaller group of women (N= 306), as 30% of Type D and 21% of non-Type D women were smokers, although not reaching statistical significance (p= 0.13). Type D personality was also associated with a lower prevalence of current or previously medically treated hypertension in women (60% vs. 73%, p= 0.047; OR 1.7, 95% CI: 1.01-3.08), while no differences were seen in blood-lipid lowering treatment.

Finally, the prevalence of re-angiographies was higher in Type D women (30%) compared to patients in the other three patient groups combined (20%; $\chi^2_{(1,\ N=\ 1427)}= 4.26$; p= 0.039). Hence, more Type D women underwent additional angiographies after their initial angiography, during the two year study period as compared to other non-Type D women and both Type D and non-Type D men (Figure 4).

TABLE 1. Differences in traditional risk factors by gender and Type D personality.

	Men		**Women**		
	non-Type D (N= 847)	Type D (N= 274)	non-Type D (N= 236)	Type D (N= 70)	p-value[a]
CAD[b] risk profile					
Hypertension treatment	63% (532)	61% (166)	73% (169)[c]	60% (42)[c]	0.028
Blood-lipid-lowering treatment	65% (544)	67% (182)	71% (164)	62% (42)	0.30
Current smoking	23% (195)[d]	31% (85)[d]	21% (50)	30% (21)	0.022
Diabetes	14% (119)	16% (45)	12% (29)	9% (6)	0.32
Body mass index	28.6 (4.9)	28.5 (4.7)	28.6 (4.9)	28.5 (4.7)	0.27

[a]Significant differences (p< 0.05) at the four group level (between non-Type D men, Type D men, non-Type D women and Type D women).

[b]CAD: Coronary Artery Disease.

[c]Significant difference (p< 0.05) between non-Type D and Type D women.

[d]Significant difference (p< 0.05) between non-Type D and Type D men.

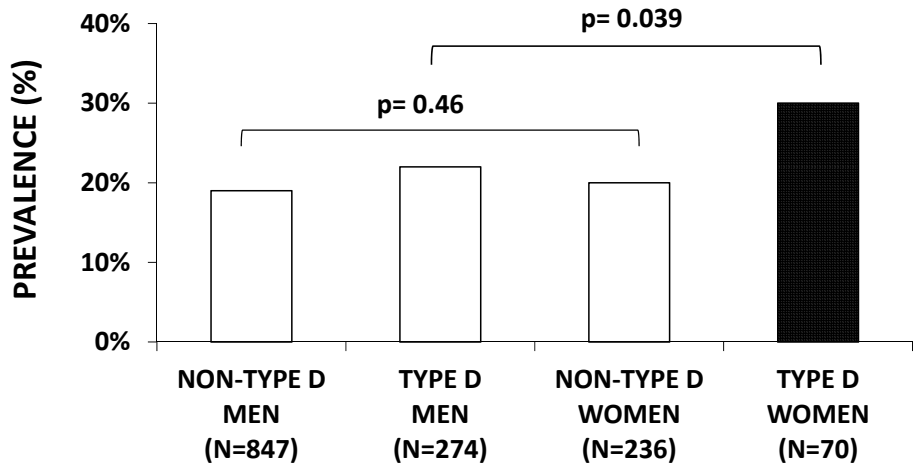


Figure 4. Prevalence of re-angiographies by Type D personality and gender.

DISCUSSION

In this nationwide study in Iceland, important gender differences were observed. Most importantly among women, Type D personality was associated with younger age at the index CAG (equaling a younger age at CAD diagnosis), a higher risk of repeated angiographies during the two year study period, and a lower prevalence of medically treated hypertension. These associations were not found among men. Type D personality was also associated with a higher prevalence of smoking in men, but a similar trend was seen among women. No association was found between Type D personality and other traditional risk factors for CAD, disease severity or treatment decision. Prevalence of Type D personality (24%) was comparable to previous reports[6,9,21]. Studies on smoking and Type D personality have been inconclusive, with smoking differences being reported in some studies (e.g.[10,12]). The current study included a highly unselective and large sample of CAD patients, which diminishes the likelihood of selection bias or a Type I error. We found the smoking prevalence among Type D patients with CAD to be 30% compared to 23% in non-Type Ds. For comparison the daily smoking prevalence in the general Icelandic population in 2008 was 17.6%[25]. High negative affect has previously been associated with smoking[26], and the use of smoking as a strategy to control negative affect[27]. As smoking is one of the most important modifiable risk factors in patients with CVD[28], Type D patients may constitute a group in which focus on smoking cessation might be more pertinent in

secondary prevention compared to other patient groups. It is however not known how much smoking explains of the association between Type D personality and adverse prognosis, as the effect of Type D has in previous studies remained after adjustments for smoking status[29].

Important gender-related differences emerged in the association of Type D personality with the diagnosis of CAD and risk factors. Type D women were on average six years younger at the index CAG, as compared to non-Type D women. Thus, these women are diagnosed with CAD at a similar age as men, an unexpected finding since the onset of CAD usually emerges nearly ten years later in women than in men[30,31]. Type D women did not differ in disease status or previous cardiac history from non-Type D women, and received similar treatment following angiography. These findings suggest that women with Type D personality do not experience the protective effect of being female or may have other factors that counteract this protection. The incidence of CAD is increasing in younger women[32], and psychological risk factors may promote the development of arterial disease in younger women[33]. This may be due to a greater exposure to chronic stressors, and more internalized stress reactions and coping styles in women[34] which eventually may cause an increased risk of CAD[30,35].

Surprisingly, Type D women underwent more re-angiographies compared with other patients. In contrast, most studies have shown that women are less likely to undergo a CAG[36-38] and/or a revascularization[38,39] compared to men, and that this effect remains when clinical diagnosis, complaints and history are taken into account[40]. The decision to perform a CAG is complex, involving a multitude of factors[37], and thus many reasons may lie behind the inequalities seen in treatment across gender. Women tend to have more false positive exercise tests and to experience more atypical symptoms[37,38], which may lead to less clear symptom description and make them less inclined to believe their symptoms arise from coronary events[38]. Furthermore, the preferences of patients and health care providers can influence which diagnostic procedures are used[37]. Women may be less likely to accept recommendations to undergo a CAG, and health care provides less likely to offer invasive interventions to women[39]. Hence, it is not clear why Type D women underwent more re-angiographies in the current study. Their younger age may

play a part, as younger age has been shown to predict use of CAG's[41]. Previous findings have suggested that Type D patients with coronary heart disease perceive their disease as more severe than non-Type Ds independent of disease severity[42], and that Type D individuals in general report poorer physical health status[43]. Perhaps Type D women communicate more severe and unclear symptoms to their cardiologists, which as a result refer them to repeat CAG. Increasing awareness of more atypical symptoms and non-invasive diagnostic difficulties in women[38] may also play some role. In addition, Type D personality has been associated with a three-fold risk of symptoms of exhaustion after PCI treatment[44], which may be a serious symptom of main stem stenosis or three-vessel disease and might lead to a repeat angiography in symptomatic Type D women. In contrast, observations in heart failure patients suggest that Type Ds may delay consulting a doctor despite experiencing more cardiac symptoms and appraising these symptoms as worrisome[15]. Furthermore, adherence to treatment might be worse in Type D women[13], resulting in return of angina symptoms. The possibility of a more aggressive progression of CAD in Type D women after CAG and the diagnosis of CAD cannot be excluded either. Due to these conflicting results, future studies are needed to explore indications and outcomes of repeat angiographies for these groups.

Overall, Type D personality was not related to the majority of traditional risk factors, disease severity or previous history of CAD, including previous revascularization. This finding is in accordance with the notion that the increased morbidity and mortality risk associated with Type D personality is independent of disease severity and most traditional risk factors[9]. The only difference noted was the lower prevalence of medically treated hypertension in Type D women, which is contradictory to recent general population findings, where Type D women had a higher prevalence of hypertension[18]. From the current data we cannot exclude the possible explanation that Type D women have the same or higher incidence of hypertension as non-Type D women, as the measurement was based on treatment of hypertension and the difference lay in that they simply receive less medical treatment. Type D personality has previously been associated with a lower prevalence of hypertension treatment, but then only in men[19]. Further examinations are needed on the risk factors and treatment at admission and discharge from hospital for these groups.

The current findings need to be interpreted with caution. Information regarding education, socio-economical and family status, and cardiovascular medications were lacking, as well as concrete measures of certain risk factors. These factors may potentially influence the association between Type D and cardiac health. Furthermore, the women group was considerably smaller than the men group, which limited the statistical power to distinguish actual differences among women. This disparity was however expected, as CAD is generally more prevalent in men[45]. Conversely, the unique strength of the study is its all comers and nationwide design along with the fact that it was based on one of the hitherto largest samples of Type D patients. Furthermore, the sample represented a broad group of CAD patients with a definitely confirmed diagnosis in patients undergoing CAG in the only hospital providing invasive cardiology services in Iceland. Hence, this study effectively portrays the population of CAD patients in the country as non-selectively and unbiased as possible.

In summary, Type D personality was associated with a younger age at index CAG, less medically treated hypertension and more re-angiographies in women, but not in men. Type D personality was related to a higher smoking prevalence, but not with other traditional risk factors, disease severity, or treatment administered in CAD patients. Further research is needed to uncover the mechanisms that may explain the adverse cardiovascular effects of Type D personality, and to further examine gender-related differences in the risk associated with psychological distress.

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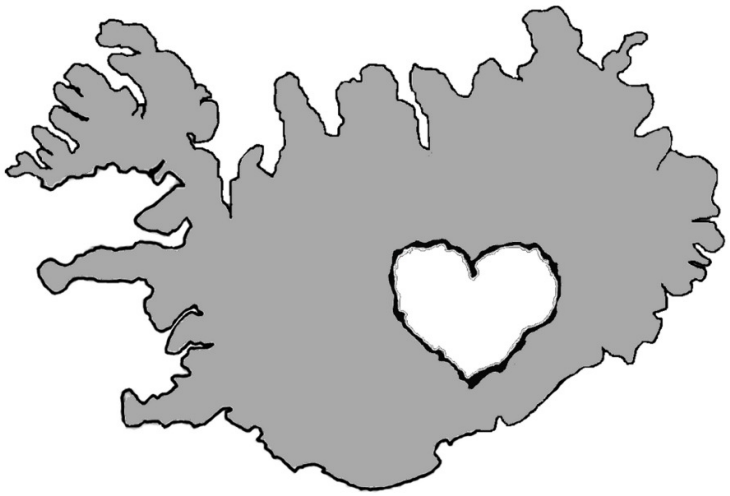
CHAPTER 4 | TYPE D PERSONALITY IS ASSOCIATED WITH IMPAIRED PSYCHOLOGICAL STATUS AND UNHEALTHY LIFESTYLE IN ICELANDIC CARDIAC PATIENTS: A CROSS-SECTIONAL STUDY



Svansdottir E, van den Broek KC, Karlsson HD, Gudnason T, Denollet J. Type D personality is associated with impaired psychological status and unhealthy lifestyle in Icelandic cardiac patients: A cross-sectional study. *BMC Public Health 2012;* 12:42.

ABSTRACT

Background: Type D (distressed) personality has been associated with adverse cardiac prognosis and poor emotional well-being in cardiac patients, but it is still unclear what mechanisms link Type D personality with poor clinical outcomes in cardiac patients. In the present cohort of Icelandic cardiac patients, we examined potential pathways that may explain this relationship. The objectives were to examine (1) the association between Type D personality and impaired psychological status, and to explore whether this association is independent of disease severity; and (2) the association between Type D personality and an unhealthy lifestyle.

Methods: A sample of 268 Icelandic coronary angiography patients (74% males (N= 199); mean age 62.9 years (SD 10.5), range 28-85 years) completed the Type D Scale (DS14), Hospital Anxiety and Depression Scale (HADS), and Perceived Stress Scale (PSS) at hospitalization. Health-related behaviors were assessed four-months following angiography. Clinical data were collected from medical files.

Results: Type D personality was associated with an increased risk of anxiety (OR 2.97, 95% CI: 1.55-5.69), depression (OR 4.01, 95% CI: 1.42-11.29), and stress (OR 5.99, 95% CI: 3.08-11.63), independent of demographic variables and disease severity. Furthermore, fish consumption was lower among Type Ds, as 21% of Type Ds versus 5% of non-Type Ds consumed fish < once a week ($p< 0.001$). Type D patients were also more likely to smoke at follow-up (17% versus 8%; $p= 0.024$) and to use antidepressants (17% versus 9%, $p= 0.049$) and sleeping pills (49% versus 33%, $p= 0.019$) compared to non-Type Ds. Type D personality was not associated with other health-related behaviors, aside from trends towards less fruit and vegetable consumption, and more weight gain.

Conclusion: Type D personality was associated with psychological distress and an unhealthy lifestyle in Icelandic cardiac patients. Future studies should further investigate the association between Type D personality and health-related behaviors.

INTRODUCTION

Evidence linking psychological factors with adverse prognosis in patients suffering from cardiovascular disease (CVD) has accumulated in recent years[1,2]. In this realm of research, one specific personality construct, the Type D (distressed) personality, has shown particular promise as a potential risk factor for poor prognosis in CVD patients. The Type D personality refers to high scores on two stable personality traits, negative affectivity (NA) and social inhibition (SI), and portrays individuals who frequently experience negative emotions (elevated NA), but tend to inhibit emotional expression due to fear of rejection (elevated SI)[3].This combination of elevated negative affect and high social inhibition is thought to have a negative impact on clinical outcomes in cardiac patients, rather than one of the two personality traits alone[4].

The Type D personality concept was originally developed to identify cardiac patients at risk of developing emotional and interpersonal difficulties[3,5], and has as such been strongly associated with psychological comorbidity in cardiac patients, e.g. post-traumatic stress disorder[6], anxiety[7-9], depression[9,10], and vital exhaustion[11]. However, further research revealed that Type D personality is also associated with increased morbidity[12], mortality[13-15] and a poor quality of life[16] across diverse CVD patient groups, where it has been associated with a three-fold increased risk of poor prognosis[17]. Several studies have demonstrated that the effect of Type D personality on adverse outcomes is independent of biomedical risk factors, such as hypertension[14,16] and disease severity, comprised by multi-vessel disease and left ventriculal function[14,18]. With a prevalence of 25-38% in cardiac patients[14,19-21], Type D personality can potentially influence the prognosis and well-being of a substantial number of cardiac patients.

It is still unclear what mechanisms link Type D personality with poor clinical outcomes in CVD patients[22]. Mediating mechanisms may include both physiological and behavioral factors[13,23,24]. Recent findings have suggested that negative health-related behavior[22] and inadequate consultation behavior[25] may play a role in the behavioral factor vicinity. Individuals experiencing psychological distress may for instance be more prone to use maladaptive coping styles, such as increased smoking and poor diet[26], which again can negatively impact the disease process. Further investigations on how Type D

personality influences the health of cardiac patients are needed, especially since such analysis would provide clues for possible targets for intervention in these patients[13,14]. In addition, there is also a need for more cross-cultural investigations on Type D personality and its influence, since previous investigations have primarily focused on samples of Belgian and Dutch origin[27].

The aim for the present study was twofold: (1) to investigate the relationship of Type D personality with anxiety, depression and stress in Icelandic cardiac patients, and to explore whether this association is independent of indicators of disease severity; and (2) to investigate the relationship of Type D personality with certain health-related behaviors in these patients.

METHODS

Participants

The original participant sample consisted of 315 patients who underwent a coronary angiography at Landspitali-University Hospital from January to May 2008. These patients were a part of a larger study, the "Risk factors, prognosis and success of medical procedures in patients undergoing coronary angiography at Landspitali-University Hospital", and were included in the current study because they answered additional questionnaires measuring anxiety, depression and stress at baseline. Participants were first approached when hospitalized to the coronary care unit or upon arrival to the emergency ward. Follow-up assessments were administered with a phone call to participants in July 2008, approximately four months after discharge (M= 106 days, (SD 27.2 days)). A total of 268 patients (85%) completed the follow-up, and were included in the final study sample. Of the excluded 47 patients (15%), six patients (2%) were deceased, one patient lived abroad and was therefore not included in follow-up, three individuals (1%) refused to participate in the follow-up and the remaining 37 (11%) could not be reached. The follow-up group did not differ in age from the patient group not reached at follow-up (M= 62.9 years (SD 10.5) versus M= 65.4 years (SD 9.3); t(313)= 1.56, p= 0.12). The study protocol was approved by the medical ethics committee of The

National Bioethics Committee in Iceland. The study was conducted conform to the ethical tenets developed by the World Medical Association, as espoused in the Declaration of Helsinki. All patients provided written informed consent.

Demographics

Information concerning gender and age was gathered from medical records, while data concerning educational level (elementary, higher education (secondary or university)) and family status (living alone/widowed, married/living with partner) were collected by self-report from participants.

Clinical variables measured at baseline

Information regarding disease classification, traditional Coronary Artery Disease (CAD) risk factors, and disease severity were retrieved from patients' medical records. Information on disease status was classified as follows: CAD, Myocardial Infarction (MI), arrhythmias, heart valve disease and heart failure. Traditional CAD risk factors were defined in the following way: smoking (no, yes); hypertension (no hypertension treatment, current hypertension treatment); on blood-lipid lowering medication (no, yes); diabetes (no, yes); and overweight (Body Mass Index, BMI). Disease severity was defined by (a) the number of coronary arteries affected by CAD (0 or 1 artery versus ≥ 2 arteries), and (b) cardiac history (previous Percutaneous Coronary Intervention (PCI), previous MI, and/or a previous Coronary Artery Bypass Surgery (CABG)).

Measures

All participants were administered the Icelandic versions of the Type D scale (DS14)[19], the Hospital Anxiety and Depression Scale (HADS)[28] and the Perceived Stress Scale (PSS)[29] at baseline, when hospitalized for a coronary angiography.

The DS14 comprises two seven-item subscales (NA and SI) in order to measure the tendency to experience negative emotions (NA "*I am often irritated*") and the tendency to inhibit self-expression in social interactions (SI "*I am a closed kind of person*"), the two components of Type D personality. The report answer format is on a Likert scale ranging from 0 (*false*) to 4 (*true*). Total scores on both subscales range from 0

to 28. Participants were defined as having Type D personality if they scored ≥ 10 on both subscales[19]. A recent study using item-response theory has shown the cut of ≥ 10 to be the best to distinguish between Type D and non-Type D individuals[30]. Results from factor analyses on the scale have indicated a clear two factor structure, representing negative affectivity and social inhibition[19,31,32]. The Icelandic version of the DS14 has good internal consistency (Cronbach's α= 0.87-0.88 for NA; Cronbach's α= 0.84-0.85 for SI) and psychometric evaluations have supported the construct validity of the scale[33].

The HADS measures symptoms of anxiety and depression and was specifically developed and tested in physically ill people[28]. This questionnaire contains seven items for each mood status. Participants answer on a four-point scale (0-3) how well each statement refers to them, and total scores for each domain range from 0-21. The Icelandic version of the HADS identifies symptoms of depression and anxiety sufficiently well[34], and reliability estimates across various studies range from 0.78-0.86 for anxiety and 0.65-0.85 for depression[35]. Continuous scores on the HADS were used for the main analysis and dichotomous scores were used for a logistic regression. Depression and anxiety scores on HADS were categorized in a similar way as recommended by the authors, with the exception that borderline symptoms and full symptoms were pooled into one category, such that scores ≥ 8 indicated presence of symptoms of anxiety and depression.

The PSS is a 14-item questionnaire which measures perceived stress[29], more specifically, the degree to which situations in one's life are appraised as stressful. Items include questions such as "*In the last month, how often have you felt nervous and stressed*" and "*In the last month, how often have you felt that you were unable to control the important things in your life?*" Responses are measured on a five-point Likert scale ranging from 0 (*never*) to 4 (*very often*), and the total score ranges from 0 to 56. The PSS has good psychometric properties[29,36]. The Icelandic version of the PSS has comparable psychometric properties to the original version[37], with reliability coefficients of α= 0.89 in a healthy sample and α= 0.90 in a patient sample[38]. In the current study, continuous scores were used for the main analysis. To indicate heightened symptoms of perceived stress, we used a cut-off score at the 75th percentile.

Health-related behaviors measured at four-month follow-up

Assessment of health-related behaviors was conducted four-months after discharge, by a phone call by a researcher to participants, where standard questions regarding exercise, diet, smoking and psychopharmacological medication use were administered. Specific questions included: (a) whether patients engaged in sufficient exercise per week (>20 minutes 3x a week); (b) whether patients had gained weight after discharge (yes, no); (c) rehabilitation attendance after discharge (yes, no); (d) whether they had breakfast every morning (yes, no); (e) daily consumptions of fruits and vegetables (not daily, daily); (f) frequency of fish consumption (< once per week, weekly); g) smoking (yes, no); and (h) regular use of sleeping pills, antidepressants, and/or anxiety-reducing medication.

Statistical analyses

Prior to analysis, missing values on the DS14, HADS and PSS were replaced if the number of missing items per participant did not exceed three on the DS14 and HADS subscales, or four for the total PSS scale. Missing items were replaced with each participant's average score on the subscale the missing items belonged to. For each scale, replaced missing items were ≤ 1% of the total number of items. Four patients (1.5%) did not complete the HADS scale adequately and were excluded from all analysis that included HADS scores. Sixteen patients (6%) had ≥ four items missing on the PSS scale, and were excluded from analysis involving PSS scores.

Differences in demographics, clinical variables and health-related behavior between Type D and non-Type D individuals were explored with chi-square calculations for nominal variables and independent t-test for continuous variables. Independent t-tests were administered to examine basic differences in anxiety, depression and stress scores between Type D and non-Type D patients. The association of Type D personality with anxiety, depression and perceived stress was assessed with multiple linear regressions. Each separate model was implemented with a hierarchical entry, where Type D personality was inserted at the first step, while age, gender, disease severity, cardiac history, education and family status were added in the second step as covariates. Two

outliers were identified in the anxiety and depression models and excluded from further analysis in those models. Underlying assumptions were inspected for each regression model and indicated no problems. The effect size for differences in anxiety, depression, and perceived stress scores by Type D personality were estimated using Cohen's D calculations. Linear regression analysis was used to test the unique and shared predictive power of both Type D components for anxiety, depression and stress, where continuous NA and SI scale scores (0-28) were included as predictors instead of Type D personality. Each linear regression model was run twice, first with NA inserted at the first step and SI at the second step, and then with SI inserted at the first step and NA at the second step, in order to assess the unique explained variance of NA and SI. Furthermore, a logistic regression, which incorporated the same covariates as the linear regression, was conducted to assess the odds ratio associated with Type D patients for manifestation of increased symptoms of anxiety, depression, and stress. For this analysis, all predictors were inserted into the model simultaneously using the enter method.

Finally, a re-analysis was conducted for all significant associations where the Type D/non-Type D categorization (≥ 10 on NA and SI) was substituted with continuous NA and SI scale scores[39]. Inter-quartile ranges were used to rescale NA and SI scores and the NA by SI interaction term, so that a one unit difference represented a clinically relevant metric. Within the NA inter-quartile distribution, 70% (N= 49) of Type Ds fell within the 4^{th} quartile, and 30% (N= 21) within the 3^{rd} quartile. For SI, 49% (N= 34) of Type Ds fell within the 4^{th} quartile and 51% (N= 36) within the 3^{rd} quartile. In the inter-quartile NA by SI scores, 89% (N= 62) of Type Ds were within the 4^{th} quartile and 11% (N= 8) within the 3^{rd} quartile. Linear regression models for anxiety, depression and stress were re-executed, with NA, SI and the NA by SI interaction term entered at the first step and covariates at the second. For health-related risk markers, binary logistic regression analyses (stepwise procedure) were used with NA, SI and the NA by SI interaction term as predictors.

All analyses were two-tailed and alpha < 0.05 was used to indicate statistical significance. The SPSS 17 statistical software for Windows was used for the analysis (Statistical Package for Social Sciences, Chicago, IL, USA).

RESULTS

Demographical and clinical variables

Mean age in the sample was 62.9 years (SD 10.5) and males were more prevalent (74%, N= 199) than females. A total of 26% of patients were defined as having Type D personality, which is in line with previous research[3,19-21]. Baseline characteristics of Type D and non-Type D individuals are presented in Table 1. Type D patients were on average younger than non-Type D patients, but no differences emerged in gender distribution, family status or educational level between groups. Likewise, prevalence of traditional CAD risk factors was similar across groups, except that Type D patients were less likely to be on hypertension treatment compared to their non-Type D counterparts. No difference was found in disease severity, as measured by the number of vessels affected by CAD, nor previous cardiac history (former PCI, MI and/or CABG) between Type D and non-Type D participants.

The association of Type D personality with anxiety, depression and stress

Type D patients had significantly higher anxiety, depression and perceived stress scores compared to their non-Type D counterparts (M= 9.7 (SD 2.6) versus M= 7.7 (SD 2.2), $t(262)= 5.92$, $p< 0.001$ for anxiety; M= 6.0 (SD 2.3) versus M= 4.7 (SD 1.4), $t(86.2)= 5.54$, $p< 0.001$ for depression; M= 21.8 (SD 6.4) versus M= 15.9 (SD 5.7), $t(250)= 7.02$, $p< 0.001$ for perceived stress; see Figure 1). Further analysis with multiple linear regressions showed that the association between Type D personality and higher scores on anxiety, depression and perceived stress was independent of age, gender, family status, education, disease severity and cardiac history. In all cases, Type D personality had a strong association at the first step (explaining 13%, 11% and 16% of variance in anxiety, depression and stress scores, respectively), and the association remained when covariates were inserted into the model at the second step. The inclusion of covariates contributed to a 6% increase in explained variance of anxiety scores, but did not significantly improve model fit for depression or perceived stress (see Table 2).

Analysis of the unique and shared predictive power of both Type D subcomponents revealed that the association between Type D and anxiety was primarily driven by NA (31% of the variance), while the total variance explained by both factors was

TABLE 1. Differences in demographical and clinical variables between Type D and non-Type D patients*.

	Total (N= 268)	non-Type D (N= 198)	Type D (N= 70)	p-value
Demographics				
Age (Mean (SD))	62.9 (10.5)	63.6 (10.6)	60.7 (10.1)	0.045
Male	74% (199)	73% (146)	27% (53)	0.75
Female	26% (69)	75% (52)	25% (17)	
Widowed/living alone	22% (59)	21% (42)	24% (17)	0.59
Elementary education (N= 267)	39% (105)	38% (75)	43% (30)	0.48
Disease				
Coronary artery disease	69% (186)	69% (136)	71% (50)	
Myocardial infarction	11% (30)	12% (24)	9% (6)	
Arrhythmia	4% (10)	3% (5)	7% (5)	
Heart valve disease	4% (12)	5% (10)	3% (2)	
Heart failure	2% (4)	2% (3)	1% (1)	
Unspecified chest pain/other	10% (26)	10% (20)	9% (6)	
CAD risk factors and disease severity**				
Hypertension treatment	60% (157)	65% (126)	45% (31)	0.004
High blood-lipids treatment	65% (170)	67% (129)	60% (41)	0.36
Diabetes	11% (29)	11% (22)	10% (7)	0.80
Current smoking (baseline)	22% (59)	19% (38)	30% (21)	0.067
BMI (Mean (SD))	28.9 (5.0)	28.9 (4.9)	28.7 (5.1)	0.70
≥ two vessel disease	39% (105)	39% (78)	39% (27)	0.90
Previous PCI, MI or CABG	30% (80)	33% (64)	23% (16)	0.13

*Data are presented as percentages (N) unless otherwise specified.

**Due to missing values N varies between 262 and 268 patients.

34%. SI did not significantly contribute to this model of anxiety; the shared variance of both factors was 2.5%. Conversely, both NA and SI contributed to the association with depression and perceived stress, with 9% shared variance for both measures. The unique effect of NA was larger in both cases, with NA and SI explaining 9% and 4% of depression scores and 17% and 1% in perceived stress scores, respectively. The effect sizes

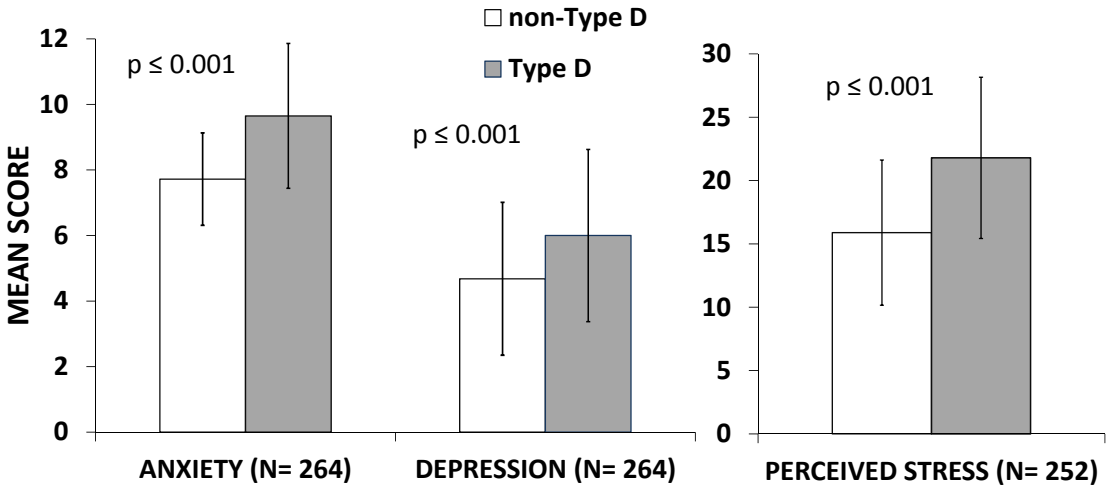


Figure 1. Differences in average anxiety, depression and stress scores by Type D personality (with 95% confidence intervals).

TABLE 2. Multiple linear regression of anxiety, depression and perceived stress scores by Type D personality and covariates.

	Anxiety (N= 256)			**Depression (N= 256)**			**Perceived stress (N= 244)**		
	B	**β**	**R^2**	**B**	**β**	**R^2**	**B**	**β**	**R^2**
Step 1			0.13			0.11			0.16
Type D personality	1.88	.36**		1.23	.33**		5.76	.41**	
Step 2			ΔR^2=0.06, p=0.010			ΔR^2=0.04, p=0.074			ΔR^2=0.03, p=0.22
Type D personality	1.74	.33**		1.19	.32**		5.54	.39**	
Age	-0.05	-.21**		0.01	.04		-0.09	-.15*	
Gender (female)	0.80	.15*		-0.63	-.17*		0.51	.04	
Family status (married)	0.29	.05		-0.39	-.10		-0.33	-.02	
Higher education	-0.18	-.04		-0.45	-.13*		-1.24	-.10	
≥ two vessel disease	-0.02	-.00		-0.28	-.08		0.27	.02	
Previous cardiac history	-0.06	-.01		-0.10	-.03		0.83	.06	

*p ≤ 0.05; **p ≤ 0.001.

associated with Type D personality were high (Cohen's d= 0.78, 0.74, and 0.93 for anxiety, depression, and perceived stress respectively).

Multivariate logistic regression analyses replicated these findings, indicating that Type D patients had about three to four times greater odds of experiencing some symptoms of anxiety (OR 2.97, 95% CI: 1.55-5.69, p≤ 0.001) and depression (OR 4.01, 95% CI: 1.42-11.29, p≤ 0.009), and nearly six times greater odds of heightened perceived stress (OR 5.99, 95% CI: 3.08-11.63, p≤ 0.001) compared to non-Type D patients, independent of covariates.

Health-related behavior

A comparison of health-related behavior four-months after discharge between groups indicated that diet, medication use and smoking cessation may differ between Type D and non-Type D patients (Table 3). First of all, fish consumption was considerably less frequent among Type D patients. A total of 21% of Type Ds consumed fish less than once a week compared to only 5% of non-Type Ds ($\chi^2_{(1,N=268)}$= 16.40; p< 0.001). A trend towards less consumption of fruits and vegetables in Type D patients was found as well, but 81% of non-Type Ds versus 70% of Type Ds consumed fruits and vegetables on a daily bases ($\chi^2_{(1,N=267)}$= 3.44, p= 0.064). However, no differences were found regarding whether patients had breakfast every day. Likewise, no difference was found in exercise between groups. A trend towards Type D patients being more likely to have gained weight after the angiography compared to non-Type D patients was found although not significant ($\chi^2_{(1,N=268)}$= 3.37; p= 0.066). A separate analysis was conducted post-hoc in overweight patients (BMI ≥ 25) to explore this matter further, and revealed that 18% of overweight Type D patients reported having gained weight after the angiography compared to 8% of non-Type D patients ($\chi^2_{(1,N=221)}$= 4.47; p= 0.035). At follow-up, the prevalence of smoking was 17% in Type D patients versus 8% in non-Type D patients ($\chi^2_{(1,N=266)}$= 5.09; p= 0.024). A similar trend for smoking was noted at baseline, although not significant. Finally, more patients with Type D personality reported use of antidepressants (17% versus 9%; $\chi^2_{(1,N=263)}$= 3.86; p= 0.049) and sleeping pills (49% versus 33%; $\chi^2_{(1,N=261)}$= 5.46; p= 0.019), compared to their non-Type D counterparts. However, no difference was found in reported anxiety medication use between groups.

TABLE 3. Prevalence of certain health-related behavior practices across groups at follow-up*.

	N	Total	non-Type D	Type D	p-value
Exercise					
Minimal exercise (< 20 min 3x a week)	268	11% (29)	11% (21)	11% (8)	0.85
Have attended rehabilitation	263	30% (78)	28% (55)	33% (23)	0.43
Weight					
Gained weight after the angiography	268	11% (30)	9% (18)	17% (12)	0.066
Gained weight (obese patients, BMI≥ 25)	221	10% (23)	8% (13)	18% (10)	0.035
Diet					
Have breakfast every day	267	90% (240)	91% (179)	87% (61)	0.38
Consume fruits and vegetables every day	267	78% (208)	81% (159)	70% (49)	0.064
Consume fish seldom (≤ 1 a week)	268	9% (25)	5% (10)	21% (15)	0.001
Smoking					
Smoking prevalence at follow-up	266	10% (27)	8% (15)	17% (12)	0.024
Psychopharmacological medication use					
Use sleeping pills regularly	261	37% (96)	33% (63)	49% (33)	0.019
Use antidepressants regularly	263	11% (29)	9% (17)	17% (12)	0.049
Use anxiety-reducing medication regularly	263	12% (32)	11% (22)	15% (10)	0.49

*Data are presented as percentages (N) unless otherwise specified.

Secondary analysis of significant results using re-scaled Type D scale scores

NA was a significant predictor for anxiety (b= 0.65, p< 0.001), depression (b= 0.30, p = 0.006), and stress (b= 0.36, p= 0.001), and SI was a significant predictor for depression (b= 0.25, p= 0.009). After adjustment for these NA and SI main effects, the interaction term of NA by SI was not significant in these analyses of anxiety, depression and stress. In binary logistic regression models of health-related behaviors, the NA by SI interaction term was associated with higher odds of smoking at follow-up (OR 1.50, 95% CI:1.01-2.21, p= 0.04) and less fish consumption (OR 0.48, 95% CI: 0.31-0.74, p= 0.001), and NA with more use of antidepressant medications (OR 1.89, 95% CI: 1.29-2.77, p= 0.001). No

association was found between NA, SI, or NA by SI with weight gain (in patients with BMI ≥ 25) or use of sleep medication.

DISCUSSION

This study investigated the association between Type D personality and psychological distress in Icelandic cardiac patients, explored whether the association is confounded by indicators of disease severity, and examined the relationship between Type D personality and certain health-related behaviors. As expected, patients with Type D personality had a worse psychological status compared to their non-Type D counterparts, which was independent of the patient's demographic status and markers of disease severity. These results are in support for the notion that Type D personality is associated with impaired psychological well-being in cardiac patients, and are congruent with previous findings[8,9], where Type D has been associated with a three-fold risk of increased psychological distress[17]. Further analysis revealed that the association between Type D and poor psychological status was mainly driven by NA, but that SI also had a significant unique contribution to depression and perceived stress. NA and SI shared considerable variance in depression/stress scores, indicating the effect of Type D personality. Other researchers also found that the interaction of NA and SI predicted increased stress levels[24].

Regarding health-related behaviors, Type D patients displayed a lower prevalence of fish consumption and a trend towards less fruit and vegetable consumption compared to non-Type Ds, as well as a predisposition to smoke at follow-up and a higher prevalence of sleep- and antidepressant medication use. The higher prevalence of psychopharmacological medication use has been noticed previously, where post-MI patients with a Type D personality were significantly more likely to use benzodiazepines as compared to non-Type D patients[40], and provides further support to the current findings that Type D individuals experience more symptoms of anxiety, depression and stress.

The findings that Type D personality was not associated with indicators of disease severity is in line with previous findings[14,18,41], providing further evidence that Type D personality is not related to disease severity. Other studies also found no association

between psychological factors and extent of coronary atherosclerosis[42]. Hence, the adverse effects of Type D personality on cardiac prognosis may be mediated through other pathways, such as behavioral and physiological factors[13,23,24].

Apart from the unexpected link between Type D and a lower prevalence of hypertensions treatment, no association was found with the traditional CAD risk factors. This fits well with the general consensus that the influence of Type D on cardiac health is not mediated through biomedical risk factors[14,16]. The lower hypertension treatment prevalence could be due to a poorer self-management in Type D patients, as Type D has previously been associated with poor medication adherence[43]. Type D individuals are also less likely to seek appropriate medical care[44] or have regular medical check-ups[22].

Re-analyses of significant associations of Type D personality with outcome variables, using continuous NA, SI, and NA by SI scores confirmed the association of the NA and SI subscales with depression, and the main effects of NA with anxiety and stress. The NA by SI interaction term was not significant in these analyses, probably as the main effects of the Type D subcomponents were already accounted for. Regarding health behaviors, the NA by SI interaction term was associated with more smoking and lower fish consumption and NA with use of antidepressant medications. These findings suggest that categorical and dimensional definitions of Type D personality are not necessarily mutually exclusive, but represent two different ways of capturing the psychological profiles of individuals[45].

Behavioral processes are believed to constitute one of the main mediating mechanisms linking personality and psychological distress with impaired health[46] and increased CVD risk[23,26], and recent findings suggest that health-related behavior may explain 40% of the association between personality traits and mortality[47]. Thus, management of behavioral processes such as health-related behavior may be crucial to reduce distress-related CVD risk[23]. The current findings suggested that some important aspects of health-related behavior may differ between Type D and non-Type D patients. A distinct difference in fish consumption was found, and previously, Type D personality has been associated with less sensible diet in healthy individuals[22]. Healthy diet choices are considered an important part of CVD risk reduction[48], where for example increased

consumption of fruits and vegetables[49,50], fish, and reduced intake of fried foods[48,49] are recommended. Unhealthy diet has been associated with an increased risk of acute myocardial infarction worldwide, and is estimated to account for nearly 30% of the population attributable risk[49]. Thus, a predisposition towards unhealthy diet choices is a plausible mediating mechanism in the relationship between Type D personality and clinical CVD events, and as such, should be inspected more thoroughly.

Although no differences in exercise and rehabilitation were found, a trend towards a higher prevalence of weight gain was noticed in Type D patients, which was significant in a post-hoc analysis in overweight patients. Hence, overweight Type D patients may be more prone to gain weight after a coronary angiography, although how much weight these participants gained is unknown. Weight loss is of significant importance in obese individuals, and cardiac patients in particular, as it can improve or prevent many of the obesity-related risk factors for coronary heart disease[51].

Type D patients were more likely to smoke at follow-up than non-Type D patients, although this difference was not significant at baseline. Other studies have also found an association between Type D personality and smoking[33,52,53]. Difficulties with maintaining smoking abstinence have been related to neuroticism[54,55] and psychological distress[54]. Type D individuals may experience the prospect of smoke-cessation as a more threatening and stressful event, due to their tendency to experience things in a more negative way, and might therefore need more support with altering their smoking habits. Taken together, Type D individuals may need more assistance with smoking cessation and other health-related behaviors, such as changing dietary habits. Behavioral interventions to reduce psychological distress might facilitate more successful modifications of unhealthy lifestyles[56].

Assessment of Type D personality could be useful to identify patients who have an increased risk of adverse clinical events[17]. Type D personality has been associated with inadequate consultation behavior[25,57], poor medication adherence[43] and negative illness perception[58] in cardiac patients. Rozanski[59] has argued that cardiologist should consider including a brief screening of psychological factors that might influence patient behavior and adherence into their standard care. The DS14 is a short, reliable measure of Type D

that is easy to administer (2-3 minutes) and score[19], and that could be used by health professionals to identify Type D patients that may benefit from more tailored intervention in clinical care.

Little is known about the population attributable risk Type D poses for CVD incidence in the community, as the main emphasizes in Type D research has not been to assert causal connection with CVD incidence, but rather to examine the association between general distress and prognosis in cardiovascular populations[17]. As a consequence, most studies on Type D personality and coronary heart disease have been conducted in cardiovascular samples. Yet, a number of general population studies on Type D personality have exposed Type D personality as a vulnerability factor for worse self-reported health status, more somatic health complaints and disease-promoting mechanism[60], and unhealthier lifestyle behaviors[22].

Finally, the current findings support the cross-cultural validity for the association of Type D personality with psychological distress, and are consistent with recent findings from Denmark[61], Germany[62] and the United States[63]. Thus, the effect of Type D personality is not limited to Dutch and Belgian populations[9].

The results of the current study should be interpreted with some caution due to the following limitations. The participant sample consisted of a heterogeneous group of cardiac patients undergoing coronary angiography, and thus measurements of disease severity employed in this study may not portray effectively worse disease status for a small proportion of the sample (for instance in arrhythmia patients). In addition, the current findings regarding Type D and psychological status might be susceptible for reverse causation, due to the cross-sectional origin, but previous longitudinal reports demonstrating that Type D predicts onset, prevalence and severity of psychological distress after adjustments for baseline depression[17] diminish such a risk. Furthermore, health-related behaviors were assessed with self-report and not by extensive and psychometrically examined measurement devices. Yet, the current sample represented a broad group of cardiac patients undergoing a coronary angiography in the only hospital in Iceland that performs angiographies, and thus the sample portrays effectively the population of cardiac patients of a whole nation as non-selectively as possible.

Conclusions

In summary, the results of the present study indicate that Type D personality is associated with more psychological distress and unhealthy lifestyle behaviors in Icelandic cardiac patients, and support the cross-cultural validity of the Type D personality construct. Further studies should be implemented to investigate, in more detail, the association between Type D personality and health-related behavior, for such investigations could generate intervention strategies to improve the prognostic outlook for cardiac patients with Type D personality.

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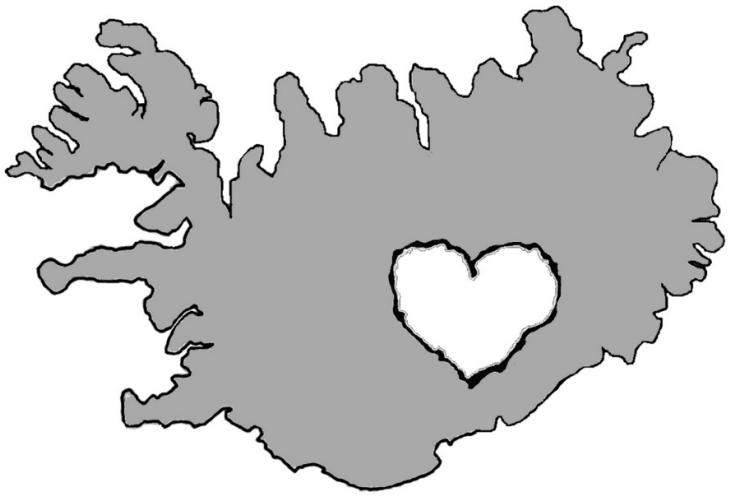
CHAPTER 5 | TYPE D PERSONALITY AND EMOTIONAL DISTRESS: THE MEDIATING ROLE OF COPING STYLE



Svansdottir E, Helgadottir F, van den Broek KC, Olason, DT, Karlsson HD, Denollet J. Type D personality and emotional distress: The mediating role of coping style. Submitted.

ABSTRACT

Objective: The distressed (Type D) personality, the combination of negative affectivity and social inhibition, has been associated with poor psychological outcomes in patients with cardiovascular disease. This study investigated if differences in coping styles mediated this association.

Methods: A sample of 216 coronary angiography patients completed the Type D scale (DS14), Hospital Anxiety and Depression Scale, and Perceived Stress Scale at baseline and follow-up (14-17 months), and the Coping Inventory for Stressful Situations at follow-up. Patients smoking status at baseline and follow-up was collected.

Results: Prevalence of Type D personality was 27%. Type D personality was associated with higher anxiety, depression and perceived stress scores at follow-up (all p's < 0.05), and emotional coping (p< 0.001), but not with task-focused (p= 0.30) or avoidance coping (p= 0.51). Likewise, emotional coping was positively correlated with anxiety, depression and stress (r= 0.45-0.63). In mediation analyses, emotional coping had a significant indirect effect in the association of Type D personality with anxiety, depression, and stress scores, indicative of partial mediation. Type D patients had higher odds of smoking at follow-up compared to non-Type Ds independent of baseline smoking (OR 3.34, 95% CI: 1.04-10.71. Overall, 57% of non-Type D and 21% of Type D smokers stopped smoking during the follow-up.

Conclusions: The association between Type D personality and increased emotional distress post coronary angiography is partially mediated by emotional coping. Furthermore, Type D patients were more likely to continue smoking during follow-up. Type D patients could benefit from stress- and coping skills training aimed at improving psychological well-being.

INTRODUCTION

Psychological factors have been associated with adverse prognosis in patients with cardiovascular diseases (CVD)[1]. The *distressed* (Type D) personality has emerged as an independent predictor for increased morbidity and mortality in patients with various cardiovascular diseases[2], although negative findings have also been reported[3,4]. Type D personality refers to the combination of two stable personality traits, negative affectivity (NA) and social inhibition (SI)[5]. It portrays individuals who simultaneously experience frequent negative emotions in their daily life (NA), but inhibit expression of their emotions due to fear of negative reactions from others (SI)[6]. Type D personality has also been associated with adverse psychological co-morbidities, such as anxiety, depression, post-traumatic stress disorder, vital exhaustion[2], and a poor patient-reported health status[7].

At present, little is known about the underlying mechanisms that may explain the association of Type D with poor psychological well-being. Personality-related differences in coping style constitute one possible pathway that may mediate this association, but use of different coping styles under stressful situations have been shown to affect the emotional states of individuals[8]. Coping refers to the process through which people manage stress. Previous study findings have suggested that individuals with Type D personality have limited ability to recover after stressful events[9] and use more passive coping strategies when dealing with stressful situations[10,11]. Such differences in coping with stressful events may also lead Type Ds to engage in negative health-behaviors, such as more smoking, to manage their stress and negative emotions. The few studies which have explored this matter have shown that cardiac patients with Type D personality use more maladaptive or passive coping[11,12], a more maladaptive emotional regulation[13], and indicated that differences in coping styles partially mediate the association of Type D personality with perceived health[14] and perceived stress[10,15]. A limitation of previous studies is, however, their cross-sectional nature, and the fact that some studies are based on healthy subject, and not clinical samples.

The aim of the current study in a sample of Icelandic cardiac patients was (a) to investigate whether Type D personality was associated with increased emotional distress

at 14-17 months follow-up, and (b) to assess whether this association was mediated by individual differences in coping. A secondary objective was to assess if patients with Type D personality would be more likely to smoke after the angiography. We hypothesized that Type D personality would be associated with increased emotional distress at follow-up, that this association would be partially mediated by coping styles, and that Type D patients would be more likely to smoke at follow-up.

METHOD

Participants

This longitudinal study included 315 patients who underwent a coronary angiography at the Landspitali-University Hospital in Reykjavik, Iceland, from January to June 2008. These patients were a part of a large study investigating risk factors, prognosis and success of medical procedures in patients undergoing coronary angiography at Landspitali-University Hospital, and were first approached when hospitalized to the coronary care unit or upon arrival to the emergency ward. The current study included a subgroup of patients that answered additional questionnaires measuring anxiety, depression, and stress at baseline.

These patients were contacted by phone 14-17 months post-angiography for a follow-up assessment. The follow-up assessment consisted of (a) questions regarding general health and health-related behaviors, which were administered during the phone call, and (b) an additional questionnaire package sent via mail, which participants could return by mail free of charge. The follow-up was conducted from August-October 2009. A total of 216/315 patients (69%) completed the follow-up and were included in the final study sample. Of the 99 patients not completing follow-up, ten patients had died (3%), 16 refused further participation (5%), 72 patients did not return the questionnaire package or could not be reached via the telephone (23%) and one patient lived abroad. The follow-up group did not differ from the patient group not reached at follow-up in gender (72% men vs. 78% men; $\chi^2_{(1,N=315)}= 1.74$, p= 0.19) or mean age (61.8 ± 11.2 years vs. 63.9 ± 9.8 years; t(313)=1.81, p= 0.07).

The study protocol was approved by the medical ethics committee of The National Bioethics Committee in Iceland. The study was conducted conform to the ethical tenets developed by the World Medical Association, as espoused in the Declaration of Helsinki. All patients provided written informed consent.

TYPE D PERSONALITY

The Type D scale (DS14)[5] is a 14-item questionnaire which measures the two components of Type D personality, e.g. NA and SI. The answer format is on a five-point Likert scale ranging from 0 (*very false*) to 4 (*very true*), and total scores on both scales range from 0-28. Participants were defined as having Type D personality if they scored ≥ 10 on both subscales[16]. The original version of the scale has good psychometric properties[5], and the psychometric properties of the Icelandic version have been verified, indicating good reliability for both subscales (Cronbach's α= 0.86 for NA, Cronbach's α= 0.85 for SI)[17].

Symptoms of depression, anxiety and stress

The Hospital Anxiety and Depression Scale (HADS)[18] measures anxiety and depression, and is intended for patients with somatic diseases. The scale consists of 14 propositions, seven for each subscale, and participants answer on a four-point scale (ranging from 0-3) how well each proposition fits with them. Total scores for both anxiety and depression range from 0-21. The HADS scale has ample reliability and validity for measuring anxiety and depression in patients[19,20], and the Icelandic version of the scale has good reliability (Cronbach's α= 0.65-0.85 for depression; Cronbach's α= 0.78-0.86 for anxiety) and assesses anxiety and depression sufficiently well[21]. The reliability of the subscales in this study was Cronbach's α= 0.81 for anxiety and Cronbach's α= 0.75 for depression. To indicate borderline or symptoms of anxiety and depression, HADS scale scores were categorized as recommended by the authors, with the exception that borderline symptoms and full symptoms were pooled into one category, such that scores ≥ eight indicated presence of increased symptoms of anxiety and depression.

The Perceived Stress Scale (PSS)[22] is a 14-item self-report questionnaire measuring how much stress people have experienced in their daily life in the past month and how

well they have dealt with that stress. Reponses are scored on a five-point Likert scale ranging from 0 (*never*) to 4 (*very often*). Total scores range from 0-56, with higher scores indicating heightened stress. The scale has good psychometric properties[22]. The Icelandic version of the scale has comparable psychometric properties to the original version[23]. The reliability of the scale in the current study was Cronbach's α= 0.74. To indicate heightened symptoms of perceived stress we used a cut off score at the 75th percentile.

Individual differences in coping style

The Coping Inventory for Stressful Situations (CISS)[24,25] scale is a 48-item questionnaire intended to measure how individuals respond to and cope with stressful situations and problems. The scale incorporates three subscales which represent different coping strategies, e.g. task-focused coping, emotional coping, and avoidance coping. Task-focused coping is characterized by taking action to try to address situations or problems causing distress. Individuals using emotional coping focus on regulating their distressed emotions, and avoidance coping refers to trying to avoid stressful situations by engaging in other tasks and distractions, rather than focusing on the problem at hand[24]. Each subscale contains 16-items and respondents are asked to indicate on a five-point scale (from 1 (*not at all*) to 5 (*very much*)), how much they engage in these types of activities when encountering a difficult, stressful, or upsetting situations. Scores range from 0-80 for each subscale, and the highest scoring subscale indicates which coping strategy individuals tend to use[26,27]. The psychometric properties of the CISS scale have been tested with good results[27,28]. The Icelandic version of the scale has good validity and reliability (Cronbach's α= 0.82–0.92 for the three subscales)[26].

Smoking

Data on smoking status (*yes, I smoke currently; no, I do not smoke*) at baseline and follow-up was collected to estimate prevalence of smoking cessation after the angiography. Smoking cessation was defined when patients who smoked at baseline reported that they did not smoke (anymore) at follow-up. Conversely, patients who smoked at baseline and still reported smoking at follow-up were classified as having continued smoking. Smoking

cessation is one of the foremost recommendation physicians and cardiologist give patients with CAD and/or undergoing coronary angiography[29]. Failure to stop smoking after a coronary angiography can be perceived as a behavioral manifestation of maladaptive coping in cardiac patients, especially as smokers may continue smoking as a means to deal with their stress[30,31] instead of using more healthy stress-reducing methods. Hence, patients with Type D personality may be more likely to use smoking as a coping mechanism to deal with emotional distress compared to non-Type D patients.

Demographic and clinical data

Information regarding family status (married/living together; living alone/widowed) and education (elementary; higher education) was collected by self-report from participants. Baseline clinical information regarding disease classification, disease severity and coronary artery disease risk factors was collected from medical files. Disease classification was categorized as follows: coronary artery disease; myocardial infarction; arrhythmia and/or heart valve disease; heart failure; and unspecified chest pain. Disease severity was defined as (a) the presence of significant stenosis (more than 50% blockage) in ≥ three vessels and/or the main stem and (b) previous Myocardial Infarction (MI), Percutaneous Coronary Invention (PCI), and/or Coronary Artery Bypass Surgery (CABG). Coronary artery disease risk factors included hypertension treatment (no, yes); blood-lipid lowering treatment (no, yes); diabetes (no, yes); current smoking (no, yes); and body mass index (BMI).

Statistical method

Differences in demographics, disease classification, disease severity and CAD risk factors by Type D personality were explored with independent t-tests and chi-square calculations for continuous and categorical variables, respectively. Differences in anxiety, depression and stress scores at baseline and follow-up by Type D personality were estimated with independent t-tests. To verify that differences in emotional distress scores by Type D personality were independent of baseline levels of emotional distress, linear regression models were conducted with age, gender, and baseline levels of anxiety, depression, and

stress inserted at the first step, and Type D personality at the second step. Odds ratios (OR) for increased symptoms of anxiety, depression, and stress at follow-up by Type D personality, adjusted for age, gender and baseline symptoms were estimated with binary logistic regression analyses.

The mediating effect of coping styles on the association of Type D personality with emotional distress (see Figure 1) was estimated with a simple mediation model, conducted with the SPSS PROCESS macro developed by Hayes for bootstrap analyses[32]. Prior to analysis, the association of coping styles with anxiety, depression and stress scores were explored with correlation calculations. Three separate models where conducted with anxiety, depression, and stress as the dependent variables, respectively. All models included Type D personality as the independent factor, and coping style (task-focused coping, emotional coping and avoidance coping) as the mediator, provided that they showed a significant association with anxiety, depression, and/or stress measures prior to analysis. The models estimated the total and direct effects of Type D personality, and the indirect effects of Type D personality through coping, using bootstrapping (N= 5000), and a Sobel test.

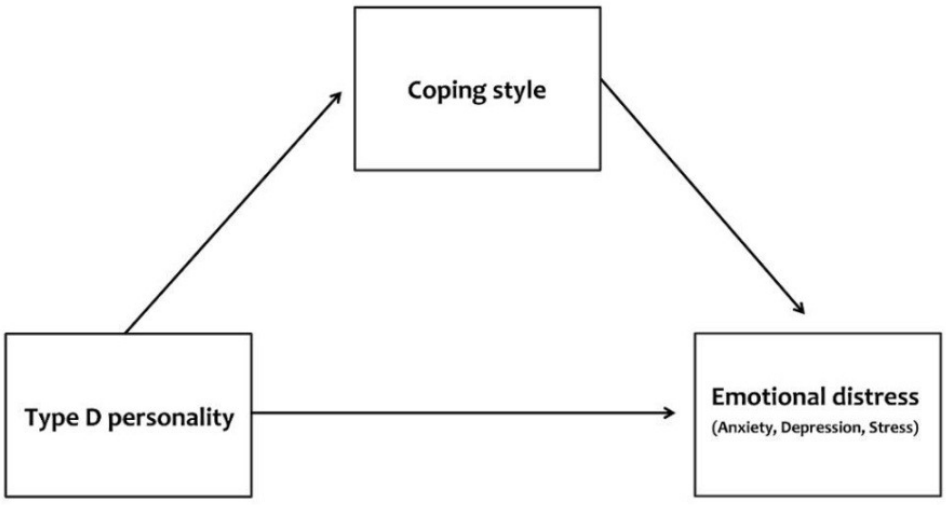


Figure 1. Model of coping as a mediator of the association between Type D personality and emotional distress.

A secondary analysis was conducted where the association of Type D personality with an alternative assessment of maladaptive behavioral coping, namely smoking as a way of down regulating distress, was explored. In this analysis, differences in smoking by Type D personality at baseline and follow-up were assessed with ordinal regression, where age, gender and Type D personality were inserted at the first step and baseline smoking status at the second step. Furthermore, differences in anxiety, depression and stress scores by smoking status at follow-up were explored with independent t-tests, which were conducted separately for patients with and without Type D personality. All analyses were conducted using the SPSS 17 statistical software (Statistical Package for Social Sciences, Chicago, IL, USA). Two-tailed tests with alpha < 0.05 were used to indicate significant differences.

RESULTS

Information on demographics, disease classification, disease severity, and CAD risk factors at baseline for the total sample, and stratified by Type D personality, is presented in Table 1. Prevalence of Type D personality was 27% (N= 59). No differences were noted in disease classification, disease severity or CAD risk factors at baseline by Type D personality, except that Type D individuals were less likely to be on current hypertension treatment (p= 0.02).

Association of Type D personality with emotional distress at follow-up

Individuals with Type D personality scored higher on anxiety, depression, and perceived stress at both baseline and follow-up assessments (Figure 2). The association of Type D personality with higher anxiety (Beta= 0.13, p= 0.021, R^2= 0.43), depression (Beta= 0.12, p= 0.032, R^2= 0.42), and stress scores (Beta= 0.17, p= 0.006, R^2= 0.32) at follow-up remained significant after adjustment for age, gender, and baseline levels of anxiety, depression and stress (respectively). Overall, Type D individuals had two to three times higher odds of increased symptoms of anxiety, depression, and stress at follow-up, independent of baseline symptoms (OR 2.25, 95% CI: 1.04-4.88 for anxiety, OR 2.77, 95% CI: 1.06-7.26 for depression; OR 2.45, 95% CI: 1.19-5.03 for perceived stress).

TABLE 1. Demographics and clinical status of patients at baseline by Type D personality.

	Total (N= 216)	**non-Type D (N= 157)**	**Type D (N= 59)**	**p-value**
Age; M (SD)	63.9 (9.9)	64.6 (10.1)	62.1 (9.0)	0.10
Gender (male)	72% (155)	73% (114)	70% (41)	0.65
Widowed/living alone	25% (54)	24% (38)	27% (16)	0.68
Elementary education	41% (87)	42% (65)	37% (22)	0.56
Disease				
Coronary artery disease	68% (147)	69% (108)	66% (39)	0.71
Myocardial infarction	12% (26)	13% (20)	10% (6)	0.61
Arrhythmia/heart valve disease	9% (20)	9% (14)	10% (6)	0.78
Heart failure	1% (2)	1% (1)	2% (1)	0.47
Unspecified chest pain	10% (21)	9% (14)	12% (7)	0.52
Disease severity				
Main stem/three-vessel disease	23% (50)	22% (35)	25% (15)	0.63
Previous cardiac history*	27% (58)	30% (46)	21% (12)	0.18
CAD risk factors				
Hypertension treatment	61% (130)	66% (102)	48% (28)	0.02
Blood-lipid lowering treatment	66% (139)	65% (100)	68% (39)	0.64
Diabetes	10% (21)	10% (16)	9% (5)	0.70
Current smoking	20% (42)	18% (28)	24% (14)	0.34
Body mass index	28.6 (4.8)	28.7 (4.7)	28.4 (5.2)	0.74

*Defined as a history of previous myocardial infarction, percutaneous coronary intervention or coronary artery bypass surgery.

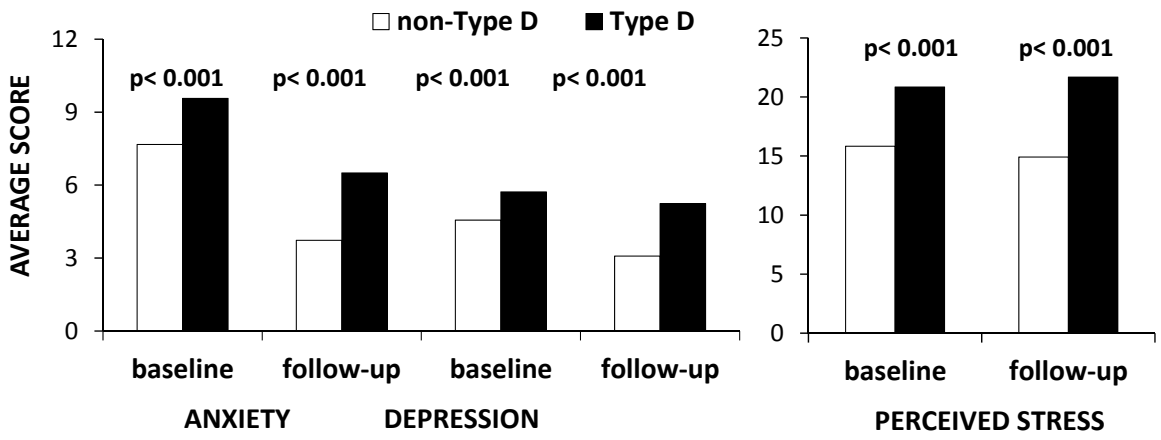


Figure 2. Differences in anxiety, depression and stress scores by Type D personality

Coping style as a mediator of the association between Type D and emotional distress

Prior to analysis of mediation, the association of coping styles with Type D personality and emotional distress were assessed. Type D personality was associated with higher scores on emotional coping (41.7 ± 11.0 vs. 32.4 ± 11.1, $t(211)= 5.55$, $p< 0.001$), but not with task-focused coping ($p= 0.30$) or avoidance coping ($p= 0.51$).

Emotional coping was positively correlated with anxiety ($r= 0.63$) depression ($r= 0.45$) and stress scores ($r= 0.61$). Task-focused and avoidance coping were not associated with emotional distress measures, aside from a low correlation between avoidance coping and anxiety scores ($r= 0.15$, $p= 0.03$). Therefore, emotional coping was included in the mediation analyses of the influence of coping style on the association of Type D personality with anxiety, depression and stress (Table 2). All three models indicated that Type D personality had a significant total effect on emotional distress, with Type Ds scoring on average 2.7 and 2.2 points higher on anxiety and depression, respectively, and 6.7 points higher on perceived stress; all p's< 0.001). All of these associations were partially mediated by emotional coping (indirect effect), as noted by the lower strength of the direct effect of Type D personality (lowering by 1.6 and 0.9 points for anxiety and depression, respectively, and by 3.7 points for stress).

TABLE 2. Emotional coping as a mediator of the association between Type D personality with emotional distress at follow-up.

	Point estimate	Bootstrapping 95% CI	Product of coefficient	
			SE	Z-score
Anxiety	1.61	0.95-2.49	0.36	4.43**
Depression	0.88	0.41-1.53	0.27	3.29**
Perceived stress	3.73	2.33-5.55	0.81	4.63**

Association of Type D personality and emotional coping with smoking

Changes in smoking status from baseline to follow-up were examined to assess whether Type D individuals would be less likely to stop smoking after the angiography (Figure 3). No difference was found in smoking prevalence at baseline, but patients with Type D personality were more likely to smoke at follow-up compared to non-Type Ds (OR 2.73, 95% CI: 1.13-6.59). Interestingly, the association of Type D personality with smoking at follow-up was stronger when baseline smoking status was taken into account (OR 3.34, 95% CI: 1.04-10.71). Of the total smokers at baseline, 57% of non-Type Ds (N= 16) versus only 21% of Type D patients (N= 3) reported having stopped smoking during the follow-up. Individuals in the Type D patient group who still smoked at follow-up had higher mean levels of anxiety (8.5 ± 4.7 versus 6.0 ± 3.4, p= 0.05), depression (8.1 ± 4.7 versus 4.6 ± 3.1, p= 0.004), and perceived stress (26.6 ± 10.0 versus 20.6 ± 7.8, p= 0.04), as compared to Type D patients who reported no smoking at follow-up. Conversely, no differences were found in anxiety, depression and stress scores between smokers and non-smokers at follow-up in the non-Type D patient group (p= 0.17, p= 0.66, and p= 0.15, respectively). Overall, patients who smoked at follow-up scored higher on emotional coping (40.5 ± 12.8 vs. 34.4 ± 11.6, t(210)= 2.372, p< 0.05), as compared to non-smokers at follow-up. No differences were noted in task-focused (p= 0.76) or avoidance coping (p= 0.68) between smokers and non-smokers at follow-up.

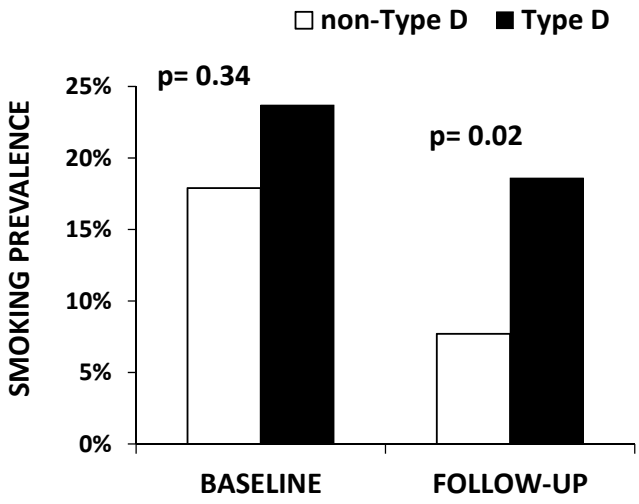


Figure 3. Prevalence of smoking status at baseline and follow-up by Type D personality.

DISCUSSION

The main findings of the current study were that Type D personality was associated with increased emotional distress in patients 14-17 month post coronary angiography, and that this association was partially mediated by emotional coping. Overall, patients with Type D personality had around two and a half higher odds of experiencing symptoms of anxiety, depression and stress, independent of baseline levels/symptoms. These findings confirm the status of Type D personality as a marker for increased emotional distress[2], but more importantly, give an indication about the psychological pathways that may explain this propensity for emotional distress in Type D patients.

The tendency of patients with Type D personality to deal with stressful situations with emotional coping may contribute to their higher anxiety, depression, and stress levels at follow-up. Use of emotional coping entails for instance a tendency to ruminate and become emotional in response to stress[33]. Emotional coping has previously been linked with higher anxiety and depression scores[34,35], which further confirms its status as a plausible mediating factor. These findings are in agreement with recent study findings where emotional coping mediated the association of Type D personality with perceived stress in young healthy individuals[15], and provide more robust evidence for this relationship, due to the longitudinal design and clinical sample of the current study. Type

D personality has also been associated with poor psychological health status and more maladaptive coping in cardiac rehabilitation patients, where patients with Type D personality seem to focus more on their distress and report more self-blame[12]. No differences were noted in the use of task-focused or avoidance coping between Type Ds and non-Type Ds, and thus they were not considered as possible mediating factors. However, avoidance coping has previously been shown to partially mediate the association of Type D personality with perceived stress in university students[10]. Further research is needed to explain these different findings.

The current findings also indicate that patients with Type D personality may be less successful with smoking cessation after an angiography compared to non-Type D patients. Type D personality was associated with nearly three-fold higher odds of smoking at follow-up, and the strength of the association was stronger when baseline smoking status was taken into account. Continuation of smoking in patients after an angiography may imply a behavioral manifestation of maladaptive coping. Smoking cessation is considered to be the cornerstone of primary and secondary CAD prevention[36], and marks the foremost recommendation cardiologist give their patients[29]. Thus, patients who fail to stop smoking after an angiography may be perceived as not dealing with their illness situation in the most efficient way. In addition, smoking was associated with elevated emotional distress in patients with Type D personality, but not in non-Type D patients. It is well known that smokers in general frequently attribute their smoking behavior to stress relief[30,31]. Perhaps Type D patients are more prone to keep smoking as a, albeit unhealthy, means to down regulate their emotional distress, instead of employing more adaptive coping methods. Notably, smoking in general at follow-up was linked with more emotional coping, implying that continued smoking may represent some means of emotional regulation.

Coping strategies play a central role in how individuals deal with stressful events. The process of undergoing coronary angiography and receiving a diagnosis of a cardiac disease can be a highly stressful event in a patient's life, and adequate coping may be essential in such circumstances. A diagnosis of CAD can for instance necessitate regular check-ups with physicians, prescriptions of numerous medications, and modification of various unhealthy lifestyle behaviors, which can be strenuous for many patients. Previous

evidence suggests that patients with Type D personality do not do well with managing the burdens of CAD diagnosis and treatment. For instance, Type D personality has been associated with poor medication adherence in cardiac patients[37,38], unhealthier lifestyle behaviors in coronary angiography patients three months post angiography[39], and inadequate consultation behavior in heart failure patients[40,41]. Non-adherence to prescribed treatment, such as medications and dietary recommendations, are again contributing factors for hospital readmissions[42], and can thus be detrimental for prognosis in cardiac patients. Likewise, maladaptive coping has been shown to fully mediate the association between Type D personality and perceived health[14]. Based on this, it seems that Type D patients might benefit from training in adequate coping skills to help them manage their disease and treatment. Self-management techniques have been developed to improve coping skills aimed at reducing stress, and enhancing patient's adherence to medication and recommended changes in unhealthy lifestyle behaviors[42]. For instance, coping skills training has been shown to improve patient's self-management of disease[43], and courses in stress management have beneficial effects on psychological functioning in cardiac patients[44]. Type D patients might benefit greatly from such interventions in clinical practice.

The following limitations need to be taken into consideration when interpreting the current findings. Assessment of emotional distress (anxiety, depression and stress) was based on self-report and not clinical evaluations. Thus, it is unclear if increased emotional distress indicated clinically relevant levels of distress. Furthermore, 31% of the original sample was not reached at follow-up, which decreases the power of the study findings, and increases the changes of selection bias.

Taken together, emotional coping partially mediates the relationship between Type D personality and increased emotional distress at 14-17 months follow-up in coronary angiography patients. Furthermore, Type D patients were more likely to continue smoking during follow-up, possibly as a means to down regulate their emotional distress. Future investigations should investigate in more detail whether maladaptive coping styles contribute to adverse self-management in Type D patients, and to what extent Type D patients would benefit from special stress- and coping skills training aimed at improving their disease management.

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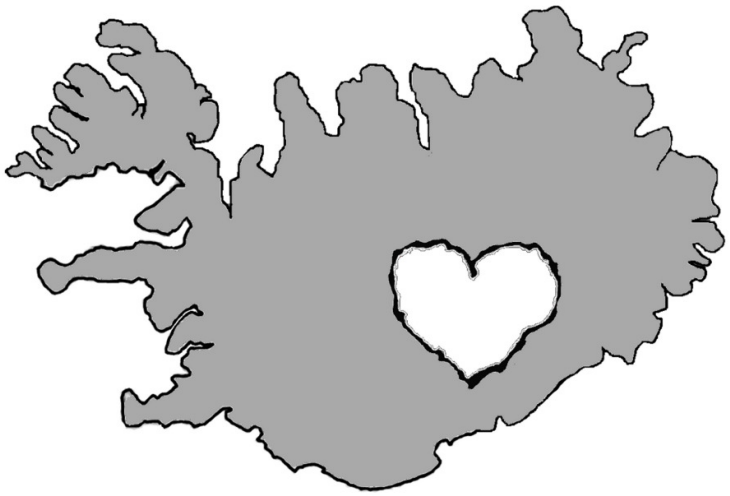
PART II | TYPE D PERSONALITY AND CARDIOVASCULAR HEALTH IN THE GENERAL POPULATION IN ICELAND

CHAPTER 6 | THE DISTRESSED (TYPE D) AND FIVE-FACTOR MODELS OF PERSONALITY IN YOUNG HEALTHY ADULTS AND THEIR ASSOCIATION WITH EMOTIONAL INHIBITION AND DISTRESS



Svansdottir E, van den Broek KC, Karlsson HD, Olason TD, Thorgilsson H, Denollet J. The Distressed (Type D) and Five-Factor Models of personality in young healthy adults and their association with emotional inhibition and distress. Submitted.

ABSTRACT

Background: The distressed (Type D) personality (the combination of negative affectivity and social inhibition traits) has been associated with adverse health outcomes. This study investigated the validity of the Type D construct against the Five-Factor Model (FFM) of personality, and its association with emotional control and distress.

Methods: In total 498 university students (mean age 28.9 ± 8.4 years) completed the Type D scale (DS14), and measurements for the FFM of personality, emotional control, anxiety, depression and stress. Participants provided self-reported use of psychopharmacological medications and previous mental health problems.

Results: The construct validity of the Icelandic DS14 was confirmed. The Type D components negative affectivity and social inhibition were strongly associated with neuroticism and extraversion of the FFM (r= 0.82 and r= -0.67, respectively). Negative affectivity also correlated with rehearsal/rumination (r= 0.58) and social inhibition correlated with emotional inhibition (r= 0.54), indicative of emotional control. Type D personality (40% of sample) was associated with higher levels of anxiety, depression and stress, use of psychopharmacological medications, and previous mental health problems.

Conclusions: The Type D personality components were associated with the FFM of personality, emotional control and emotional distress. Of importance, social- and emotional inhibition were closely related.

INTRODUCTION

The distressed (Type D) personality construct is defined by the combination of two broad personality traits, negative affectivity (NA) and social inhibition (SI). It portrays individuals who frequently experience negative emotions in daily life (elevated NA), and tend to be insecure in social interactions and refrain from sharing their emotions with others (elevated SI). Type D personality was developed from existing personality theory[1,2], in efforts to identify cardiovascular patients vulnerable for emotional difficulties[3]. Subsequently, Type D personality emerged as a marker for negative health outcomes in cardiovascular disease[4] and non-cardiovascular patients[5], and in the general population[6].

Only a few studies (e.g.[3,7,8]) have examined how Type D personality fits within the framework of other more comprehensive models of personality, such as the Five-Factor Model of personality (FFM)[9]. The FFM describes the basic dimensions of personality, and encompasses the traits of neuroticism and extraversion, which bare strong similarities to negative affectivity and social inhibition, respectively. Similarly, information has remained sparse regarding how the Type D personality subcomponents are related to emotional control, and more specifically emotional regulation within the social inhibition subcomponent[10]. Validating the presence of such emotional inhibition within the Type D personality construct is of vital importance, as the adverse effect of Type D personality on health-related outcomes is postulated to result from the chronic psychological distress of inhibiting, or holding back, expression of negative emotions[1]. Initial evidence supports that Type D personality is associated with emotional control[3], and suppressed anger[11], but more information concerning the validity of the Type D construct is needed.

The aim of this study in young, healthy individuals was threefold: (1) to evaluate the Type D construct within the framework of the FFM of personality; (2) to focus on the role of emotional inhibition within social inhibition; and (3) to examine Type D as a potential marker of emotional distress in this sample.

METHODS

Participants

The participant sample of this study consisted of 498 healthy individuals (393 women (79%), mean age 28.9 ± 8.4 years, range 18-64 years) from the University of Iceland. Participants were recruited in March 2006 by an email sent to students asking for volunteers to participate in the study. The email included a link to a secure webpage where students could fill out the questionnaires online. The study was conducted conform to the ethical tenets of the World Medical Association, as espoused in the Declaration of Helsinki.

The DS14 scale

Type D personality was measured with the Type D (DS14) scale. The 14-item scale measures the two subcomponents of Type D, i.e. the tendency to (a) experience negative emotions (NA) and (b) inhibit self-expression in social interactions (SI)[12], with seven items for each component. The NA subscale measures worry, irritability and dysphoria, but the SI subscale is intended to assess reticence, discomfort in social interaction and lack of social poise[13]. Items include "*I often feel down in the dumps*" (NA) and "*I'm a closed kind of person*" (SI). The answer format is a five-point Likert scale ranging from *strongly disagree* (0) to *strongly agree* (4), with total scores on both subscales ranging from 0-28. Type D personality was defined if participants scored ≥ 10 on both factors, NA and SI, the standardized cut-off that has been used in previous research[12,14]. The DS14 has been validated in clinical samples in various countries, such as Denmark[15], China[16] and Ukraine[17]. The validity and reliability of the Icelandic DS14 has been verified in a sample of Icelandic cardiovascular patients[3]. The scale had good internal stability in the current sample (NA: Cronbach's α= 0.87; SI: Cronbach's α= 0.88).

FFM of personality

In order to evaluate the Type D construct in the framework of the FFM of personality, the NEO-Five-Factor Inventory (NEO-FFI) was included in the study. The NEO-FFI is a 60-item self-report scale which measures five broad personality traits, i.e. neuroticism,

extraversion, openness, agreeableness and conscientiousness, with 12-items assigned for each trait [9]. The validity and reliability of the NEO-FFI has been deemed acceptable and it has been used in various settings and countries[18]. The psychometric properties of the Icelandic version of the NEO-FFI are acceptable, and its test-retest reliability and internal consistency has been deemed sufficient[19]. The reliability of the subscales in the current study ranged from Cronbach's α= 0.71-0.88.

Emotional inhibition

The Emotional Control Questionnaire (ECQ)[20,21] was used to estimate how easily people express and control their emotions. The 56-items on the scale are divided into four factors (emotional inhibition, aggression control, benign control, and rehearsal), but for the current study, a shorter version measuring emotional inhibition (i.e. inhibiting the expression of experienced emotions) and rehearsal/rumination (i.e. being preoccupied with emotional distress and worry about past and/or future events) was used[22]. The Icelandic version of this scale has adequate psychometric properties with Cronbach's α = 0.83 for rehearsal/rumination and Cronbach's α = 0.74 for emotional inhibition[23].

Emotional distress

Assessment of general emotional distress was conducted using the Hospital Anxiety and Depression Scale (HADS)[24] and the Perceived Stress Scale (PSS)[25]. The HADS measures symptoms of depression and anxiety in physically ill people[24]. The Icelandic version of the HADS identifies symptoms of depression and anxiety sufficiently well[26], with reported reliability estimates across various studies ranging from Cronbach's α= 0.78-0.86 for anxiety and Cronbach's α= 0.65-0.85 for depression[27]. Depression and anxiety scores on HADS were initially categorized as recommended by the authors, with scores from 0-7 indicating no symptoms, 8-10 borderline symptoms, and scores from 11-21 indicating symptoms of anxiety and/or depression[24]. Due to low prevalence in the higher groups, the borderline symptoms and symptoms categories were combined post-hoc to one category representing ‘some’ symptoms of anxiety and/or depression, respectively.

The PSS is a 14-item questionnaire measuring self-appraised stress[25]. The PSS scale has good psychometric properties[25,28] and correlates with social anxiety and depression

symptoms[25]. The Icelandic version of the PSS has comparable psychometric properties to the original language version[29] with reliability coefficients of Cronbach's α= 0.89 in a healthy sample and Cronbach's α= 0.90 in a patient sample[30]. To indicate heightened symptoms of perceived stress, we used a cut-off score at the 75th percentile.

As an additional assessment of emotional distress, participants were asked to indicate if they had experienced previous mental health problems, i.e. "*Have you experienced any significant mental problems in the past?*" (no, yes); and if they had used psychopharmacological medications, i.e. "*Have you used one or more of the following medications for more than two weeks in the past 12 months: sleeping pills, anxiety-reducing medications, antidepressants and/or sedatives?*" Due to a low incidence rate for each medication category, answers were recoded post-hoc to a binary variable containing the following distinction: no, I have not used any of these medications; yes, I have used one or more of these medications.

Statistical analysis

A confirmatory factor analysis was performed to confirm the two-factor structure of the DS14 scale[3], using Structural Equation Modeling (SEM) and the maximum likelihood method in the AMOS 17 (Analysis of Moment Structures, Chicago, Illinois, USA). In the construction of the model, the theoretical foundation of the scale was taken into account. As the NA and SI subscales each cover three different facets of NA and SI respectively, error covariance was added to items representing each facet[3]. Goodness of fit indexes used in the analysis included the chi-square, the Comparative Fit Index (CIF) and the Root Mean Square Error of Approximation (RMSEA). For chi-square, a value ≥ 0.05 indicates good fit (agreement with the null hypotheses that residual are minimal and the data fit the model well). The chi-square is influenced by sample size, which can lead to inflated chi-square values and thus statistical significance, indicating bad fit[31]. For the CFI, values close to 1 indicate a very good fit and values above 0.90 or close to 0.95 good fit. The RMSEA index should be ≥ 0.05 to indicate good fit, but levels ≥ 0.08 are considered to indicate adequate fit. The prevalence of Type D personality was explored with descriptive statistics.

The construct and convergent validity of the Type D personality construct was estimated with correlation calculations with similar constructs, i.e. neuroticism and extraversion of the NEO-FFI and rehearsal/rumination and emotional inhibition from the ECQ scale (representing emotional control). These associations were explored further with a second-order axis factor analysis (oblique rotation, delta= 0) of DS14, NEO-FFI and ECQ scale scores to test whether (a) NA, neuroticism and rehearsal/rumination items, and (b) SI, extraversion and emotional inhibition would load on the same latent factors, indicating similar underlying constructs. Correlation analysis between Type D personality with anxiety, depression (HADS) and perceived stress (PSS) were conducted to attest to the presence of increased negative affect and distress within the Type D personality construct.

Differences in anxiety, depression, and perceived stress scores between Type D and non-Type D individuals were estimated with t-test calculations for independent samples. Significant differences in previous mental health problems and psychopharmacological medication use by Type D personality were estimated with chi-square tests for binary variables and Tau-*c* calculations for ordinal variables. Effect sizes were estimated for significant findings with odds ratios (OR) for categorical variables. Aside from the confirmatory factor analysis, the SPSS 17 statistical software for Windows was used for all analysis (Statistical Package for Social Sciences, Chicago, IL, USA), with alpha ≤ 0.05 and two tailed tests to indicate significant differences, unless otherwise specified.

RESULTS

Dimensional structure and prevalence of Type D personality

A confirmatory factor analysis (N= 498) of the two-factor structure of the Icelandic DS14 (representing NA and SI) indicated an adequate model fit for the unconstrained model (λ^2= 224.996, p= 0.001; CFI= 0.955 and RMSEA= 0.070, CI.90: 0.06-0.08). Standardized regression weights of items to factor ranged from 0.53 to 0.85 (Figure 1). Average scores on the DS14 subscales were M= 11.0 ± 5.9 for NA and M= 11.5 ± 6.4 for SI. In total, 40%

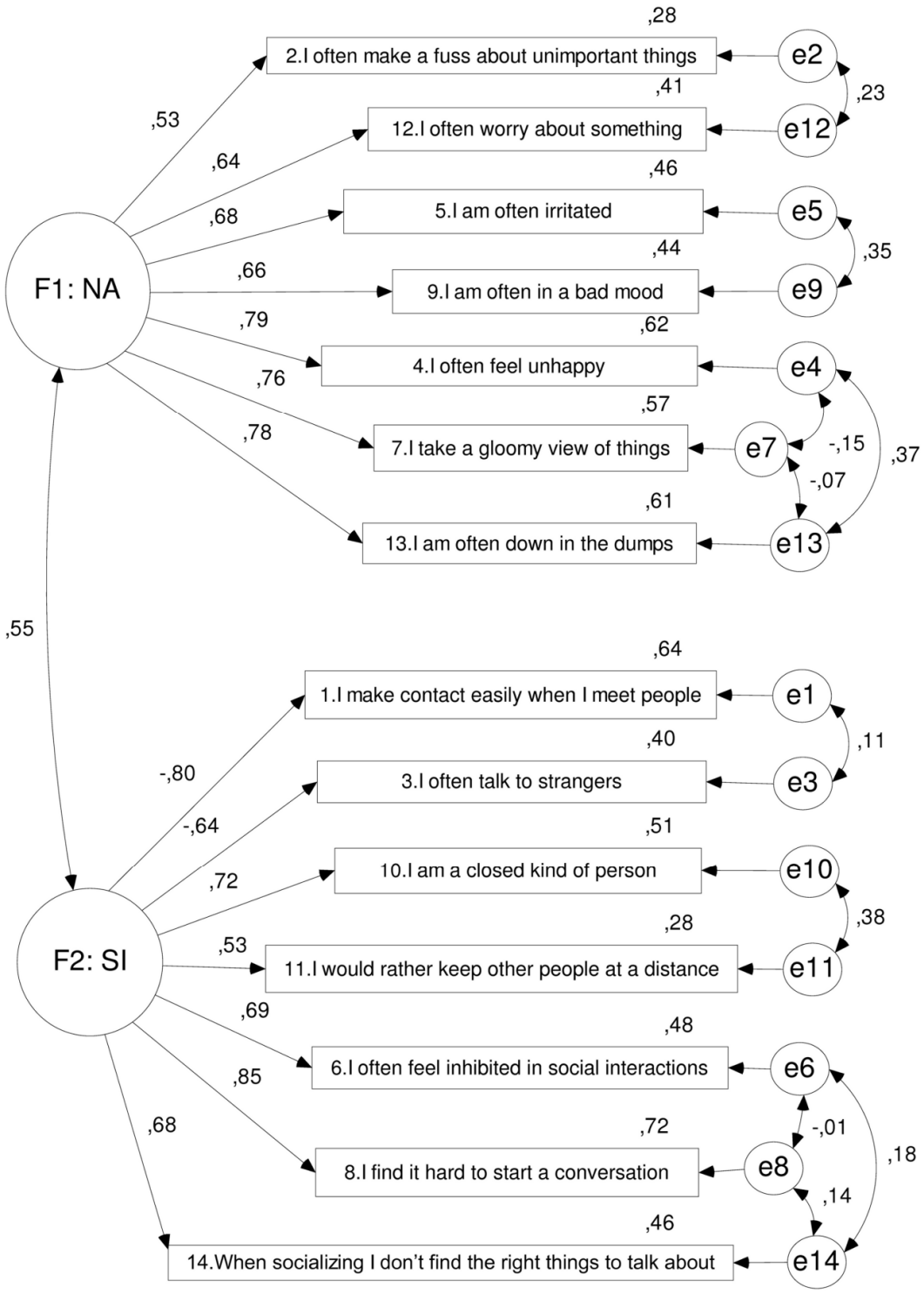


Figure 1. Standardized regression weights for the two-factor model of the DS14.

(N= 199) of participants were classified as having Type D personality. Prevalence of Type D was comparable across men (36%) and women (41%; p= 0.35).

Type D personality and the FFM

Correlation calculations of NA and SI with the FFM personality traits were performed to evaluate how the Type D subcomponents would fit within the framework of the FFM model (Table 1). These analyses revealed that NA had a strong positive correlation with neuroticism (r= 0.82) and that SI was negatively correlated with extraversion (r= -0.67). SI also had a low negative correlation with openness, but neither DS14 subscale was overly correlated with agreeableness or conscientiousness.

A second-order factor analysis on the DS14, NEO-FFI and ECQ scale scores, conducted to test the association between NA and SI with the FFM (and emotional control, presented below), confirmed that NA and SI were differentially related to the FFM of personality (Table 1). The factor solution, using eigenvalue > 1 as a cut-off and after reviewing the scree plot, resulted in three factors, which explained 51% of variance. Negative affectivity (0.96) and neuroticism (0.90) loaded together on one single factor representing 'negative affectivity'. Similarly, SI (-0.81) and extraversion (0.60) loaded together on one factor termed 'social inhibition/introversion'. The third factor consisted of a high loading of conscientiousness alone (0.63). Agreeableness loaded slightly on the negative affectivity factor (-0.31), while openness did not load on any factor.

Type D personality and emotional control

Correlation calculations between the Type D personality and emotional control subscales, revealed a modest correlation between NA and rehearsal/rumination (r= 0.58), and likewise between SI and emotional inhibition (r= 0.54). The factor analysis of DS14, NEO-FFI and ECQ scale scores (see above) further showed that rehearsal/rumination (0.65) loaded with NA (and neuroticism) on the 'negative affectivity' factor. Importantly, emotional inhibition (-0.64) loaded significantly on the 'social inhibition/introversion' factor (Table 1).

TABLE 1. Correlations and second order factor analysis of scale scores for the DS14, NEO-FFI and ECQ subscales.

	Correlation		Pattern Matrix		
	NA	**SI**	**I**	**II**	**III**
Negative affectivity	--	0.44*	**0.96**	0.08	0.07
Social Inhibition	0.44	--	0.10	**-0.81**	0.06
Neuroticism	0.82**	0.45**	**0.90**	0.03	-0.08
Extraversion	-0.48**	-0.67**	-0.22	**0.60**	0.09
Openness	-0.04	-0.11*	0.00	0.15	-0.21
Agreeableness	-0.35**	-0.27**	**-0.31**	0.17	0.08
Conscientiousness	-0.19**	-0.27**	-0.02	0.34	**0.63**
Rehearsal/rumination	0.58**	0.37**	**0.65**	-0.05	0.06
Emotional Inhibition	0.27**	0.54**	0.01	**-0.64**	-0.03

The highest loadings on the corresponding factor are presented in bold.

Type D personality and emotional distress

NA was positively correlated with anxiety (r= 0.65), depression (r= 0.56), and perceived stress (r= 0.70), indicating the presence of various symptoms of distress within the NA domain. SI was also positively correlated to these measures, albeit to a lower degree (r= 0.23, r= 0.36, and r= 0.41 respectively). Type D individuals scored higher on anxiety, depression, and perceived stress compared to non-Type D individuals (Figure 2). Altogether, 45% (N= 90) of Type Ds vs. 17% (N= 51) of non-Type Ds showed at least borderline/ symptoms of anxiety (OR 4.02; 95% CI: 2.66-6.06), and 16% (N= 32) of Type Ds vs. 2% (N= 5) of non-Type Ds presented borderline/symptoms of depression (OR 11.27; 95% CI: 4.31-29.47). Similarly, Type Ds were more likely to experience heightened perceived stress, i.e., 48% (N= 94) of Type Ds vs. 9% (N= 26) of non-Type Ds scored above the 75th percentile on PSS (OR 9.46; 95% CI: 5.80-15.43).

Prevalence of previous mental health difficulties was also higher in Type D individuals, with 38% (N= 75) of Type Ds vs. 17% (N= 49) of non-Type Ds reporting that they had suffered mental difficulties in their life (OR 3.04, 95% CI: 2.00-4.62). Type D

individuals also reported more use of psychopharmacological medications. When asked about use of anxiety-reducing medication, antidepressants, sedatives/tranquillizers and sleeping pills, 21% (N= 42) of Type D individuals reported having used ≥ one of these medications for more than two weeks over the past 12 months compared to 10% (N= 29) of non-Type Ds (OR 2.51, 95% CI: 1.50-4.19) (Figure 3).

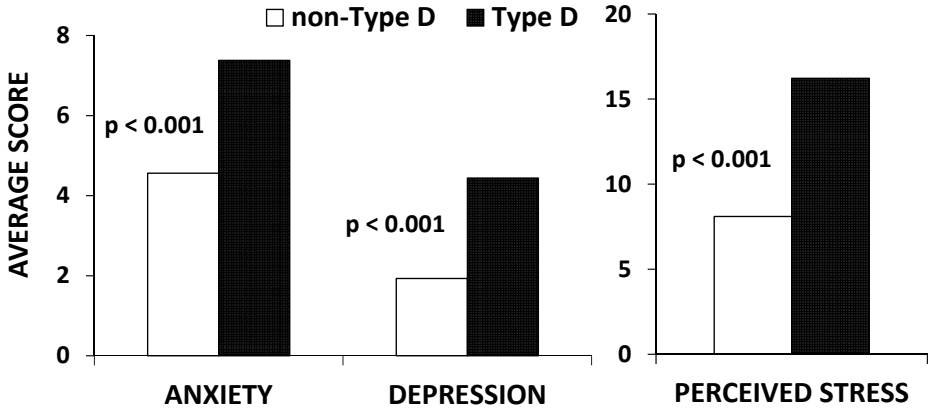


Figure 2. Differences in average anxiety, depression and perceived stress scores between Type D and non-Type D individuals (N= 498).

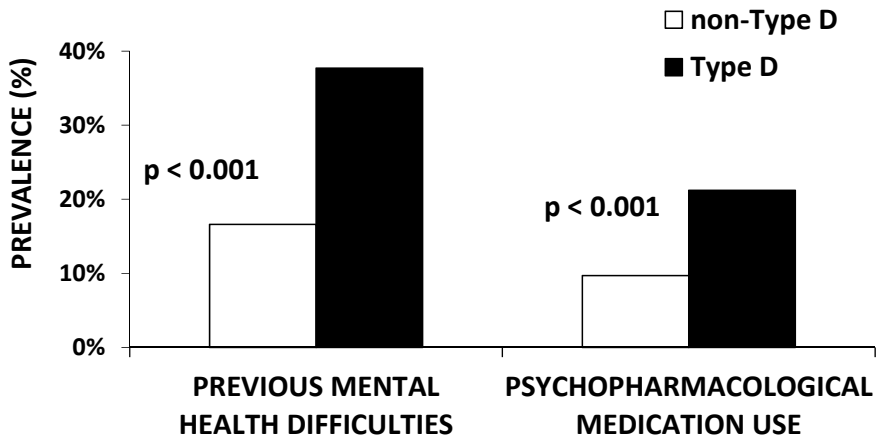


Figure 3. Differences in prevalence of previous mental health difficulties[a] and psychopharmacological medication use[b] between Type D and non-Type D participants.

[a]Have experienced significant mental problems in the past; [b]Have used more than one of the following medication for more than two weeks for the past twelve months: antidepressants, anxiety reducing, sleeping pills and sedatives/tranquillizers.

DISCUSSION

The findings of this study confirmed the factor structure of the DS14 scale[3,12] and showed the validity of the Type D construct within the framework of the FFM of personality. The NA and SI components of the Type D personality construct were well represented within the FFM framework. NA and neuroticism were closely related, and likewise SI was negatively correlated with extraversion. A second-order factor analysis of scale scores further corroborated these findings, by showing that NA/neuroticism and SI/ extraversion loaded on two distinct personality factors. These findings support the construct validity of the two Type D personality components[7,12], and are congruent with recent study results from a general population sample which has confirmed the link between NA and SI with the neuroticism and extraversion traits as measured with the Eysenck Personality Questionnaire[8].

Importantly, the current results demonstrated that both Type D personality components were associated with indicators of emotional control, and notably that SI was connected with emotional inhibition. In addition, SI was more related to emotional inhibition than to extraversion. Emotional inhibition in our study refers to what extent individuals restrain or inhibit expression of the emotions they experience[22]. A major constituent in the SI trait in Type D individuals is the tendency to inhibit expression of their true emotions and feelings, which is supposed to stem from their fear of disapproval and negative reactions from others[13]. The interaction of this tendency to hold back emotions (SI) with NA (resulting in an inhibition to express negative emotions with others), is believed to be the fundamental element that links Type D personality with adverse cardiovascular disease outcomes[32]. Investigations confirming the actual presence of such emotional inhibition within the SI trait have been largely lacking[10], with only one previous study addressing the subject[3]. The current findings thus provide valuable information by corroborating the presence of emotional inhibition in high SI (and Type D) individuals. These findings supplement previous findings which have linked SI with social avoidance[16], lack of social boldness[10] and suppressed anger[11]. Recent evidence has further suggested that maladaptive emotional regulation is more prominent in Type D individuals[33]. Deficiency in emotional regulation is one mechanism which may predispose

Type D individuals towards more emotional instability, which again may contribute to their tendency to inhibit expression of emotions.

Type D personality had strong ties to emotional distress markers in this sample of healthy young adults. NA correlated strongly with anxiety, depression and perceived stress, confirming the vulnerability for negative mood states that characterize the NA trait. Type D personality has previously emerged as an independent predictor for emotional distress, including anxiety and depression in cardiac patients[4,34], and similar associations have been noted in non-cardiovascular patients[5] and healthy individuals[8,35]. In this relatively young sample, Type D individuals were two to three times more likely to have used psychopharmacological medications or to have experienced previous mental health problems compared to non-Type Ds. A previous study has also linked Type D personality with benzodiazephine medication use in post-MI patients[1].

The 40% prevalence of Type D personality in the current study was high compared to the reported 17-39% in samples from the general population[6], but comparable to the 30-39% prevalence rates that have been noted in university based samples[8,36,37].

A number of limitations restrict the interpretation of the present findings. First of all, the participant sample was not randomly selected, and was based on a selective group of mostly female university students and collected by convenience means, and thus may not represent adequately the population of healthy Icelanders. Another limitation is the self-report of use of psychopharmacological medication and previous mental health problems. Nonetheless, the current findings ascertain the relation of the Type D personality traits with other established personality models. Moreover, these findings provide essential validity information regarding the SI component of the Type D personality construct, which have hitherto been lacking, and are fundamental for continued research on the association of the Type D personality construct with adverse health.

In conclusion, the findings supported the validity of the Type D personality construct, and confirmed that the Type D components fit well within the FFM of personality, and are closely related to emotional control. Type D personality was associated with emotional inhibition and with various markers of emotional distress in young healthy adults.

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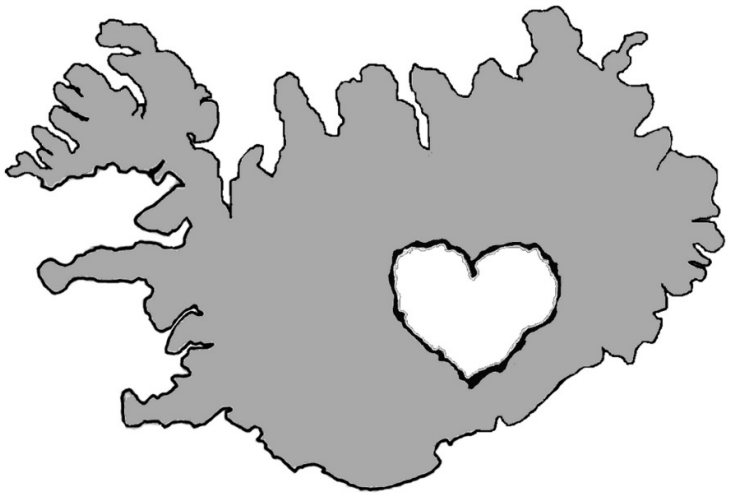
CHAPTER 7 | ASSOCIATION OF TYPE D PERSONALITY WITH UNHEALTHY LIFESTYLE, AND ESTIMATED RISK OF CORONARY EVENTS IN THE GENERAL ICELANDIC POPULATION



Svansdottir E, Denollet J, Thorsson B, Gudnason T, Halldorsdottir S, Gudnason V, van den Broek KC, Karlsson HD. Association of Type D personality with unhealthy lifestyle, and estimated risk of coronary events in the general Icelandic population. *European Journal of Preventive Cardiology* 2012; in press.

ABSTRACT

Background: Type D personality is associated with an increased morbidity and mortality risk in cardiovascular disease patients, but the mechanisms explaining this risk are unclear. We examined whether Type D was associated with coronary artery disease (CAD) risk factors, estimated risk of developing CAD, and previous cardiac events.

Design: Cross-sectional study in the general Icelandic population.

Methods: A random sample of 4753 individuals (mean age= 49.1 ± 12.0 years; 49% men) from the REFINE-Reykjavik study completed assessments for Type D personality and conventional CAD risk factors. Ten-year risk of developing CAD was estimated with the Icelandic risk calculator.

Results: Type D personality (22% of sample) was associated with a higher prevalence of hypertension (35% vs. 31%, p= 0.009), but less use of hypertension medication (58% vs. 65%, p= 0.013) in hypertensives, more diabetes (6% vs. 4%, p= 0.023), wider waist circumference (p= 0.007), and elevated body mass index (p= 0.031) and blood-lipids (p< 0.05). Type D individuals reported less physical exercise (p= 0.000) and more current (25% vs. 21%, p= 0.003) and former smoking (48% vs. 44%, p= 0.036). Estimates of 10-year risk of CAD were higher in Type D individuals (12.4%, 95% CI: 1.9 to 23.8%), and Type Ds reported more previous cardiac events than non-Type Ds (5% vs. 3%, p< 0.01; OR 1.71, 95% CI: 1.21-2.42).

Conclusions: In the general Icelandic population, Type D personality was associated with differences in lifestyle-related CAD risk factors, a higher estimated risk of developing CAD, and higher incidence of previous cardiac events. Unhealthy lifestyles may partly explain the adverse cardiovascular effect of Type D personality.

INTRODUCTION

Over the last decades, evidence has accumulated linking psychological factors with cardiovascular disease (CVD) outcomes[1]. In this area of research, Type D (distressed) personality has emerged as a predictor of poor clinical outcomes and mortality across diverse CVD groups[2,3] independent of conventional risk factors[4]. Type D personality refers to the combination of two personality traits; i.e., Type D individuals frequently experience negative emotions in daily life (negative affectivity) and are inhibited in social interaction and refrain from expressing their emotions (social inhibition)[5]. Type D is a stable[5,6] and common personality construct in clinical samples, with prevalence rates of 25-38%, and therefore has the potential to influence the prognosis of a substantial number of patients with CVD.

Both biological mechanisms, such as cortisol dysregulation[7], behavioral mechanisms[7,8], such as poor health-related behaviors[9] and poor medical adherence[10], might partly explain the adverse cardiovascular effects of Type D. However, it remains largely unknown whether and to what extent Type D personality is associated with the overall risk factor profiles in the general population, and in men and women separately. Previous findings that have linked Type D with unhealthy lifestyle behaviors[9,11-13] and other disease promoting mechanisms, such as heightened blood pressure reactivity[14] in samples from general populations, suggest that Type D personality could potentially promote initial development of CAD.

The aim of this study was to examine how Type D personality is associated with: (a) conventional and lifestyle-related CAD risk factors; (b) estimated 10-year risk of developing CAD; and (c) incidence of previous cardiac events in the general Icelandic population.

METHODS

Participants

This study is based on data from the REFINE-Reykjavik study of the Icelandic Heart Association[15]. In the REFINE-Reykjavik study, a random sample of 9478 men and women

born 1935-1985 and living in the Reykjavik area in November 2005 was drawn from the Icelandic national registry. The age distribution of the REFINE-Reykjavik study was designed to over-represent middle-aged individuals in order to concentrate the power of the study on the age span were most development in atherosclerosis is to be expected. Individuals in the study cohort received an invitation letter for participation by mail, asking them to contact the Icelandic Heart Association to make an appointment for participation. Non-respondents to the invitation letter were recruited by a trained telephone receptionist. Reason for refusing participation was documented when possible. The participation rate in the ongoing REFINE-Reykjavik study is around 76%[16].

The current study reports on an interim data analysis of the first 4753 participants in the REFINE-Reykjavik study (collected from February 2006 to July 2009). Of these, 270 (5.7%) participants were excluded from analyses due to missing personality questionnaire data, but administration of the DS14 questionnaire started subsequent to the launch of the REFINE-Reykjavik study. Hence, the final sample included 4483 participants (mean age= 49.0 ± 12.0 years, range 20-73 years, 49% men).

All participants gave informed consent at arrival to the research facilities of the Icelandic Heart Association. The REFINE-Reykjavik study was approved by the National Bioethics Committee (05-112-S1) and the Data Protection Authority.

Type D personality

Assessment of Type D personality was administered by a web-based questionnaire via the internet with the Type D scale (DS14)[5]. The Type D scale contains two seven-item subscales measuring negative affectivity ("*I am often irritated*") and social inhibition ("*I am a 'closed' kind of person*"), the subcomponents of Type D personality. The answer format ranges from 0 (*false*) to 4 (*true*), and total scores from 0-28 for each subscale. Participants were classified as Type D if they scored ≥ 10 on both subscales. A study using item-response theory has shown that the cut-off ≥ 10 best distinguishes Type D and non-Type D individuals[17]. The Icelandic version of the DS14 has good psychometric properties (Cronbach's alpha= 0.85 for negative affectivity; Cronbach's alpha= 0.84 for social inhibition)[18].

CAD risk factors

Conventional risk factors for CAD were estimated with self-report and biological measurements. For the self-report assessment, a web based health questionnaire was administered to all participants to assess various CAD risk factors and general health. Most participants answered at home, but those that had not answered when they arrived to the clinic answered at site.

Conventional risk factors included: (a) hypertension diagnosis; (b) hypercholesterolemia diagnosis; (c) diabetes; and (d) family history of CAD. Participants who reported hypertension or hypercholesterolemia were asked to indicate if they had ever been prescribed medication for their conditions (i.e. medication for hypertension and/or blood-lipid lowering medications with the answer options: yes, currently taking; yes, but no longer taking; no). Prior to analysis, the latter two categories were combined into one category representing: do not use hypertensive/ blood-lipid lowering medication. In addition to assessment of risk factors, participants were asked to indicate whether they had experienced previous cardiac events, defined as a previous myocardial infarction, and/or revascularization with a coronary artery bypass surgery or a coronary angioplasty.

Biological measurements were conducted at the research facilities of the Icelandic Heart Association. Measurements of body height, weight, hip and waist, and bio-impedance were collected by using standardized protocols. Blood pressure was measured semi-automatically (supine position, right arm). Participants blood lipids, white blood cell count, and blood chemistry were estimated from blood samples, drawn after a night fasting. Lipid measurements included total cholesterol, high-density lipoprotein (HDL), triglycerides, and calculated low-density lipoprotein (LDL). LDL was calculated with the formula total cholesterol-HDL-(triglycerides/2.2). LDL cholesterol was not calculated if triglycerides were > 4.5 mmol/l. Chemistry measurements included fasting glucose and C-reactive protein. White blood cells were counted by an automated counter. Metabolic syndrome was estimated with the International Diabetes Federation (IDF) criteria, using the European threshold for waist circumference[19].

Lifestyle-related risk factors were estimated by self-report. Items included: (a) current smoking (yes; no); (b) former smoking, i.e. "*if you do not smoke now, did you ever smoke regularly?*" (yes; no); and (c) current exercise, i.e. "*in the past 12 months, how often did you participate in moderate or vigorous physical activity?*" (never; rarely; weekly but < 1 hour/week; 1-3 hours/week; 4-7 hours/week; and > 7 hours/week). The physical activity categories were combined into three categories to enhance clarity (i.e. never or rarely; weekly but < 4 hours/week; and > 4 hours/week).

Estimated CAD risk

Participant's 10-year risk of developing CAD was estimated with the Icelandic Heart Associations' risk calculator[20] (accessible at http://risk.hjarta.is/risk_calculator/v2/) and by the Framingham risk calculator. The Icelandic risk calculator estimates risk in individuals aged 35-75 years, and takes into account age, gender, systolic blood pressure, total cholesterol, HDL, S-triglycerides, body mass index (BMI), diabetes, smoking, exercise, and family history of CAD. Risk estimates are not accurate for individuals who have experienced a previous myocardial infarction, coronary artery bypass surgery, or angioplasty; hence participants < 35 years and/or with a history of previous cardiac events were excluded from these analyses.

Statistical analysis

Comparisons of Type D prevalence by gender were conducted at different age groups spanning ten years (i.e. 20-29, 30-39, 40-49, 50-59, 60-69, and 70-74 years). Differences in age and conventional and lifestyle-related CAD risk factors by Type D personality were estimated with independent t-tests for continuous variables and chi-square tests for categorical variables. In case of skewed distributions (estimated from normality plots and skewness statistic > 1), t-tests were calculated for the natural logarithm functions of continuous variables). Confidence intervals (95%) were calculated for significant differences in continuous/biological variables. Differences in physical activity by Type D personality were estimated with Tau-*c*, due to the three-way ordinal categorization of physical activity. To compensate for different physical activity levels by age, separate comparisons were conducted in younger (20-39 years), middle aged (40-59 years), and

older (≥ 60 years) participants. Post-hoc analyses with stratification by gender were executed for the association between Type D personality and CAD risk factors, as substantial gender differences reside in presentation, symptoms and diagnosis of CAD[21]. To control for the possible confounding effects of previous cardiac events on the association between Type D personality and CAD risk factors, secondary analyses were performed for all significant associations, in the whole sample and by gender, where individuals with previous cardiac events where excluded from analysis. Effects sizes were assessed with odds ratios (OR) for binary variables, with adjustments for age (to correct for the wide age distribution) and previous cardiac events. Participants with missing values on certain variables were excluded from analyses relating to those variables.

Comparisons of the estimated 10-year risk of developing CAD were examined with univariate ANCOVA, with Type D personality as a fixed factor and age as a continuous covariate. A second multivariate model was run where potential confounders (age, sex, diabetes, current smoking, hyperlipidemia and CRP) were inserted into the model. The estimated 10-year risk of developing CAD was log-transformed before analyses. The association between Type D personality and incidence of previous cardiac events was examined with binary logistic regression, adjusting for age, in the whole sample as well as among men and women. Since first symptoms of cardiac events usually do not appear until late adulthood, with risk doubling every decade after the age of 55[22], a secondary analysis estimating the odds of previous cardiac events was conducted in individuals older than 55 years.

RESULTS

The prevalence of Type D personality was 22% (N= 1000/4483), and was similar among men and women (23% and 22%; p= 0.47), and across different age groups (Figure 1).

Association with CAD risk factors

Examinations of the relationship of Type D personality with conventional risk factors for CAD (Table 1) revealed that Type D personality was associated with slightly younger age and a higher prevalence of diabetes, family history of CAD, and hypertension, but less

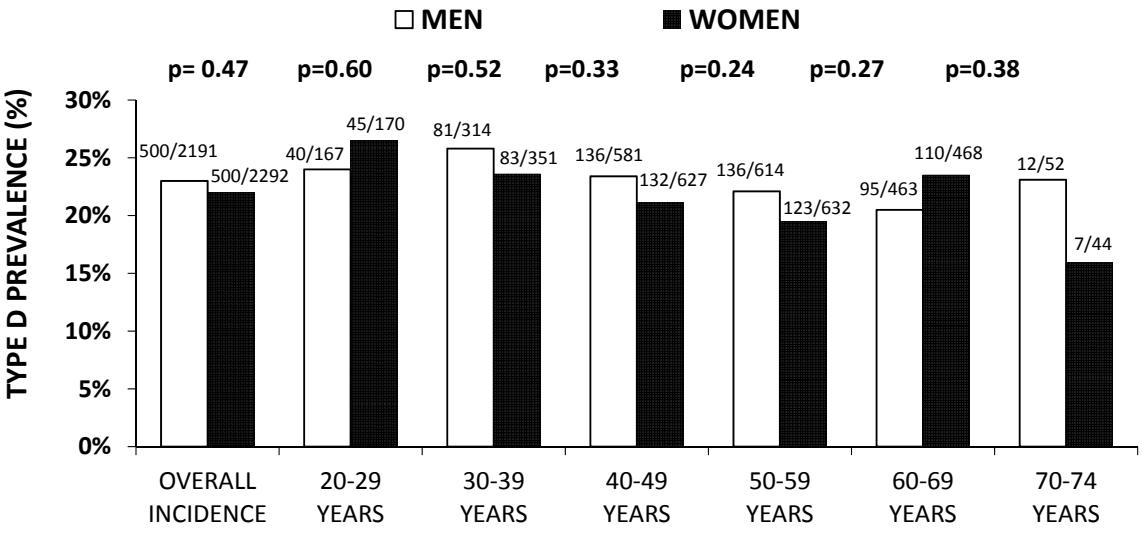


Figure 1. Prevalence of Type D personality overall and by gender and age. The individuals are shown above each column.

hypertensive medication use in hypertensives. Furthermore, Type D individuals had a higher prevalence of both current and former smoking, and were less likely to be physically active compared to their non-Type D counterparts. Differences in physical activity were especially apparent in younger individuals, but disappeared in people over 60 years (Figure 2). No differences could be seen for metabolic syndrome, hypercholesterolemia, or blood lipid-lowering medication use (in individuals with hypercholesterolemia) by Type D personality, except that when age and previous cardiac events were controlled for, an association emerged for higher odds of metabolic syndrome in Type Ds.

Regarding biological measures (Table 1), Type D personality was associated with wider abdominal circumference (98.15 cm, 95% CI: 97.26 to 99.04 vs. 96.80 cm, 95% CI: 96.37 to 97.23), higher BMI levels (27.66 kg/m^2, 95% CI: 27.34 to 27.98 vs. 27.25 kg/m^2, 95% CI: 27.09 to 27.41), lower HDL (1.47 mmol/l, 95% CI: 1.45 to 1.50 vs. 1.51 mmol/l, 95% CI: 1.50 to 1.52), and elevated S-triglycerides (1.26 mmol/l, 95% CI: 1.21 to 1.31 vs. 1.17 mmol/l, 95% CI: 1.15 to 1.20), and white blood cell count (6.20 10^9/l, 95% CI: 6.08 to 6.31 in Type Ds vs. 5.98 10^9/l, 95% CI: 5.92 to 6.04 in non-Type Ds).

TABLE 1. Prevalence of conventional and lifestyle-related risk factors by Type D personality.

	Total N	non-Type D (N= 3483)	Type D (N= 1000)	p-Value	OR (95% CI)
Conventional risk factors for CAD					
Age (years)	4483	49.3 ±11.9	48.3 ±12.4*	0.033	--
Hypertension diagnosis	4381	31% (1044)	35% (340)**	0.009	1.29 (1.10-1.52)
Hypertensive medication use[a]	1384	65% (683)	58% (197)*	0.013	0.72 (0.54-0.95)
Hypercholesterolemia diagnosis	4342	21% (718)	24% (228)	0.11	1.19 (0.99-1.43)
Blood-lipid lowering medication use[b]	946	36% (255)	35% (80)	0.91	0.90 (0.62-1.30)
Diabetes diagnosis	4483	4% (146)	6% (59)*	0.023	1.43 (1.04-1.97)
Family history of CAD	4483	34% (1183)	38% (383)*	0.011	1.25 (1.07-1.45)
Current smoking	4483	21% (726)	25% (252)**	0.003	1.27 (1.07-1.49)
Former smoking	3532	44% (1215)	48% (365)*	0.036	1.20 (1.02-1.42)
Metabolic syndrome	4472	28% (966)	31% (304)	0.09	1.19 (1.01-1.40)
Biological measurements					
BMI (kg/m²)	4479	27.25 ±4.69	27.66 ±5.20*	0.031	--
Waist circumference (cm)	4480	96.80 ±12.88	98.15 ±14.30**	0.007	--
Systolic blood pressure (bpm)	4478	122.48 ±17.02	121.97 ±16.38	0.40	--
Diastolic blood pressure (bpm)	4478	72.27 ±10.31	72.10 ±10.58	0.64	--
Total Cholesterol (mmol/l)	4481	5.20 ±1.03	5.15 ±1.00	0.20	--
HDL (mmol/l)	4481	1.51 ±0.42	1.47 ±0.41*	0.012	--
LDL (mmol/l)	4460	3.16 ±0.92	3.11 ±0.90	0.17	--
S-triglycerides (mmol/l)[c]	4472	1.17 ±0.72	1.26 ±0.83**	0.003	--
S-Glucose (mmol/l)[c]	4472	5.45 ±0.98	5.47 ±0.99	0.50	--
Lymphocyte (10^9/l)[c]	4479	1.94 ±0.66	1.99 ±0.62*	0.035	--
Monocyte (10^9/l)[c]	4479	0.51 ±0.17	0.52 ±0.17*	0.022	--
Neutrophil (10^9/l)[c]	4479	3.33 ±1.28	3.48 ±1.36**	0.001	--
White blood cells (10^9/l)[c]	4479	5.98 ±1.71	6.20 ±1.79**	0.001	--
HsCRP (mg/l)[c]	4479	2.50 ±4.11	2.66 ±4.40	0.18	--

Values are % (N) or mean ±SD. [a]Only estimated in participants with self-reported diagnosed hypertension; [b]Only estimated in participants with diagnosed hypercholesterolemia; [c]P-values computed by log-transforming values before analysis. *p<0.05; **p<0.01. BMI, Body mass index; CAD, coronary artery disease; HDL, high-density lipoprotein; HsCRP, high-sensitivity C-reactive protein; LDL, low-density lipoprotein.

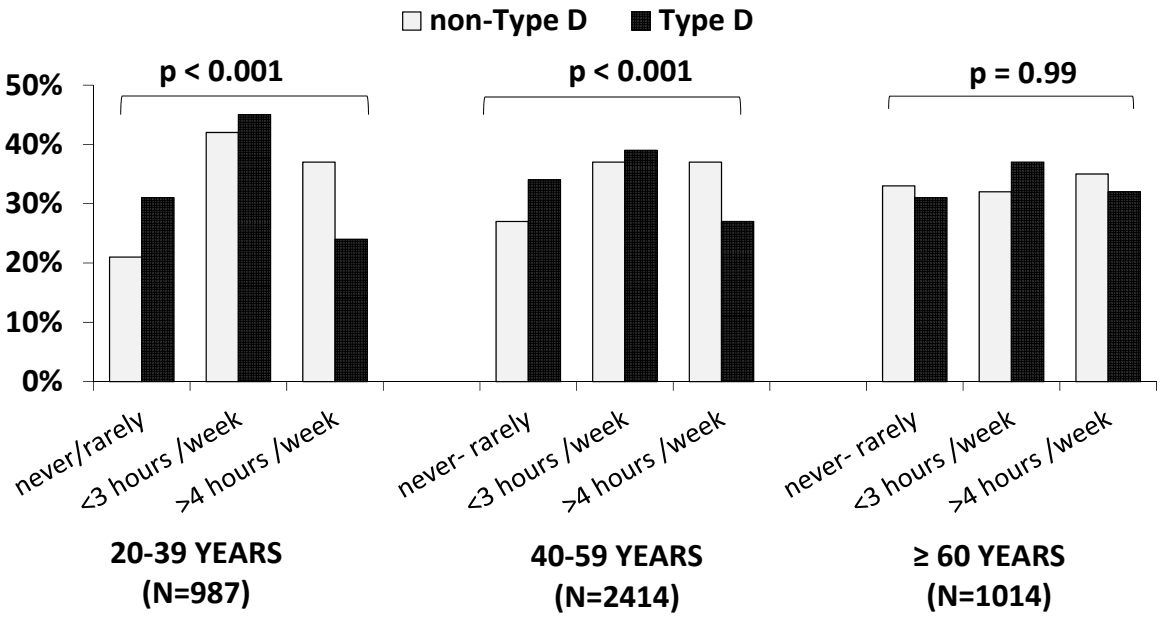


Figure 2. Prevalence of exercise by Type D personality for different age groups.

Post-hoc analysis revealed some gender differences (Figure 3). In men, Type D personality was significantly associated with a higher prevalence of hypertension (36% vs. 31%, p= 0.044), but less use of antihypertensive medication in hypertensives (53% vs. 67%, p= 0.001), more family history of CAD (36% vs. 32%, p= 0.05), a higher prevalence of current (26% vs. 21%, p= 0.027) and former (50% vs. 43%, p= 0.025) smoking, and lower HDL (1.30 ± 0.32 vs. 1.34 ± 0.34, p= 0.040). Conversely, Type D differences in diabetes prevalence (5% vs. 3% p= 0.006), S-triglycerides (1.11 ± 0.67 vs. 1.03 ± 0.58), p= 0.021), and white blood cell count (6.20 10^9/l ± 1.81 vs. 5.87 10^9/l ± 1.65, p< 0.001) were significant in women only. Differences in current smoking by Type D personality nearly reached significance in women (p= 0.054).

Secondary analyses of all significant associations between Type D personality and CAD risk factors, where individuals with a history of previous cardiac events were excluded from analysis, replicated these results (results not shown), except that differences in diabetes and former smoking prevalence by Type D personality in the whole group did not reach significance (p= 0.11 and p= 0.17, respectively).

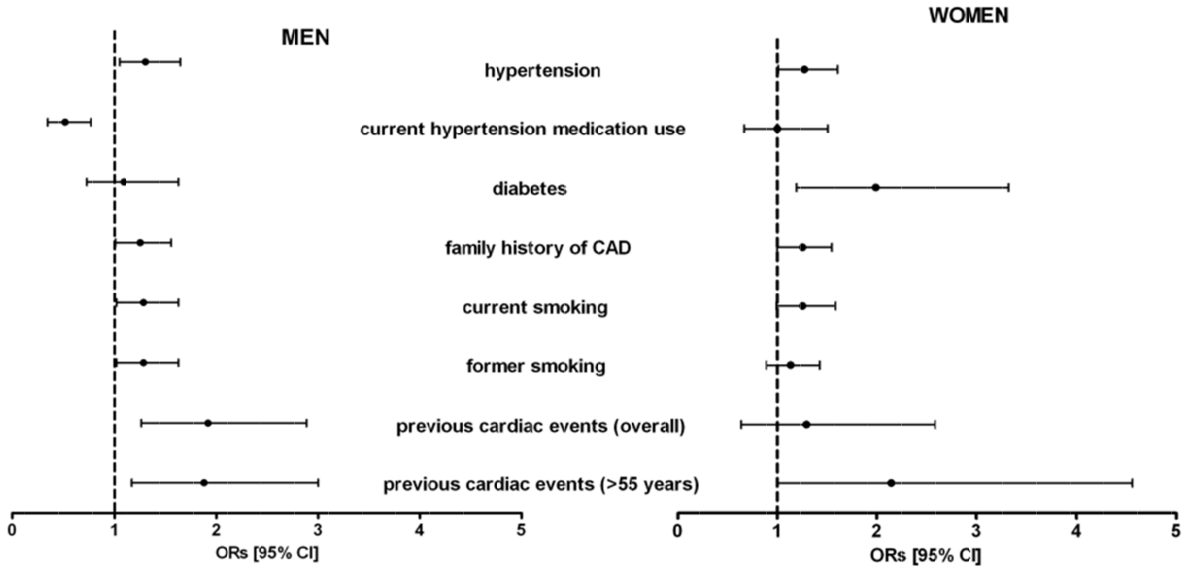


Figure 3. Odds ratios for main significant findings.

Adjusted for age and previous cardiac events, except for previous cardiac events (overall and ≥ 55 years), which are only adjusted for age.

Estimated CAD risk and previous cardiac events

In patients without previously documented CAD, Type D personality was associated with a slightly higher estimated risk of developing CAD. On average, Type D individuals had a 12.4% higher risk of developing CAD during the next 10 years as non-Type D individuals (95% CI: 1.9%-23.8%). The association remained significant when potential confounders were entered into the model (6.3%, 95% CI: 1.4 to 11.4%). The difference we found in risk estimates with the Icelandic Risk calculator was not present when using the Framingham risk score (3.6%, 95%CI: -2.0 to 9.5%). Furthermore, the incidence of previous cardiac events was higher in Type D individuals, with 5% of Type Ds vs. 3% of non-Type Ds reporting a previous cardiac event (OR 1.71, 95% CI: 1.21 to 2.42). In men, 8.2% (N= 41) of Type Ds and 5.0% (N= 84) of non-Type Ds reported having experienced previous cardiac events (p= 0.006). No differences were found in prevalence of previous cardiac events in women, who had much lower overall incidence of cardiac events than men (2.2%, N= 11, of Type D women vs. 1.8%, N= 32, of non-Type D women, p= 0.55). However, in

individuals aged 55 years or older, Type D personality was associated with an almost two-fold increase in odds of having experienced a previous cardiac event, which was present in both men and women (Figure 4).

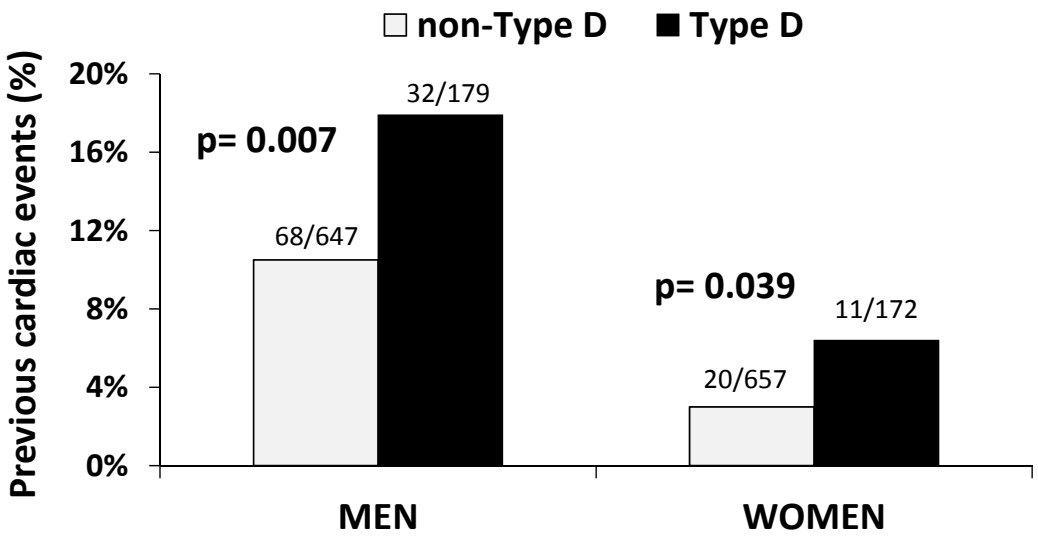


Figure 4. Prevalence of previous cardiac events (myocardial infarction, coronary artery bypass surgery or coronary angioplasty) by Type D personality in men and women aged ≥ 55 years. The numbers of individuals are shown above each column.

DISCUSSION

In the general Icelandic population, Type D personality was associated with unhealthy lifestyle behaviors, higher estimated risk of developing CAD and a marked increase in the incidence of previous cardiac events.

Type D personality was associated with some conventional risk factors for CAD, such as hypertension and use of hypertension medication, diabetes, and a family history of CAD. A few associations were seen in biological measurements (e.g. white blood cell count and blood lipids), but the absolute differences between groups were very small. Although they may have an impact at a population level, they are unlikely to have individual clinical relevance.

The association of Type D with adverse outcomes may arise from unhealthier lifestyle practices. In this study, Type D personality was associated with numerous lifestyle-related risk factors, such as a more sedentary lifestyle, more smoking, higher BMI, wider waist circumference, and higher HDL and S-triglycerides. This finding corroborates previous findings, which have also found a higher prevalence of behavior dependent risk factors[13], suggesting that Type D individuals are less physically active[11-13], perform fewer health-related behaviors[9], are less likely to invest in their fitness[23], have poorer diet choices[9,11], and have higher BMI and triglycerides levels[13]. Some studies have linked Type D personality with smoking[6,13,18,24], while other studies have found no association (for example see Mommersteeg et al.[11]). As management of unhealthy-lifestyle behaviors is considered crucial for the prevention of CVD[25], Type Ds could constitute a group that could be focused on in primary prevention. Type Ds seem to be vulnerable for more smoking and less physical activity, two widely recognized risk factors for adverse CVD development[26,27] and prognosis[28,29], and could specially benefit from more intensive assistance with changing negative lifestyle behaviors.

A recent German general population study has also found gender specific differences in the association between Type D personality and risk factors for CAD, i.e. less hypercholesterolemia in men and more hypertension in women[12]. Of note, hypertensive men with Type D personality were less likely to use medication for their hypertension in the current study, but others have shown that Type D personality is associated with poor adherence to cardiovascular medication[10] and inadequate consultation behavior[30]. Perhaps, this difference may stem from the lower utilization of medical services by men compared to women[31], which could be even more so in men with Type D personality.

Estimates of CAD risk obtained from the Icelandic risk calculator placed Type Ds at a disadvantage for developing CAD. Type Ds had on average 12% higher calculated 10-year risk of developing CAD than non-Type Ds and, after adjustments for potential confounders, Type Ds still had a 6% higher risk. Thus, when the risk factors for CAD are considered together (along with lifestyle-related risk factors), they may collectively encompass a slightly worse risk factor profile in Type D individuals. Framingham

calculations did not yield the same results, but the Framingham risk calculator differs from the Icelandic risk calculator and the European SCORE (Systematic Coronary Risk Evaluation) calculator: for example, it includes new onset angina and unstable angina as end points and overestimates risk in European populations. For these reasons, the European risk SCORE was developed[32].

Furthermore, Type D individuals had a significantly higher incidence of previous cardiac events overall, with nearly two-fold higher odds of previous cardiac events in Type D individuals aged 55 years or older. Two recent studies have also noted a similar higher incidence of cardiac events in Type D individuals in the general population[33,34].

Given the cross-sectional design of the study, causal inferences cannot be made regarding the status of Type D personality as a predictor for initial development of CAD or cardiac events. It could be that Type D individuals have more CAD risk factors and therefore a higher risk of development of CAD and cardiac events, but also that individuals with CAD risk factors develop a cardiac event and that Type D personality emerges in response to such events. However, recent evidence suggests that chronic mental stress can play a role in coronary atherosclerosis development[35] and is associated with increased risk of first myocardial infarction[36,37]. Moreover, previous studies have indicated that Type D personality is a stable personality trait[38] which is highly prevalent in the general population[14], and is not related to markers of disease severity in cardiovascular patients[6,39,40]. Hence, Type D personality does not necessarily result from cardiovascular disease severity. Importantly, this is the first article to report on Type D differences from the REFINE-Reykjavik study and these individuals will be followed for 5-10 years in order to estimate the risk of new-onset CAD associated with Type D personality.

Certain other limitations need to be taken into account when interpreting the current findings. Data on some conventional and lifestyle-related risk factors, and previous cardiac events were based on self-report and may be susceptible for recall bias, although the numerous biological measurements counteract this limitation to some extent. Furthermore, information was lacking on other important lifestyle-related factors, such as diet, which could link Type D with adverse cardiac health. Finally, differences in

CAD risk factors by Type D personality need to be interpreted with caution, due to the higher prevalence of previous cardiac events in Type D individuals. Secondary analyses of these associations, in a sample of individuals free of previous cardiac events, indicated however that the results were mostly the same, thus diminishing the risk of possible confounding by previous cardiac events.

The strength of this study lies in the unbiased random selection of participants from the general Icelandic population. This study provides novel information regarding the relationship of Type D personality (and general negative emotions) with initial development of CAD, which have to this point been sparse.

In conclusion, Type D personality was associated with unhealthy-lifestyle behaviors, a greater estimated risk of developing CAD over the next 10 years, and a higher incidence of previous cardiac events. Overall, these findings suggest that a propensity towards unhealthy-lifestyle behaviors may help to explain some of the adverse cardiovascular effects associated with Type D personality.

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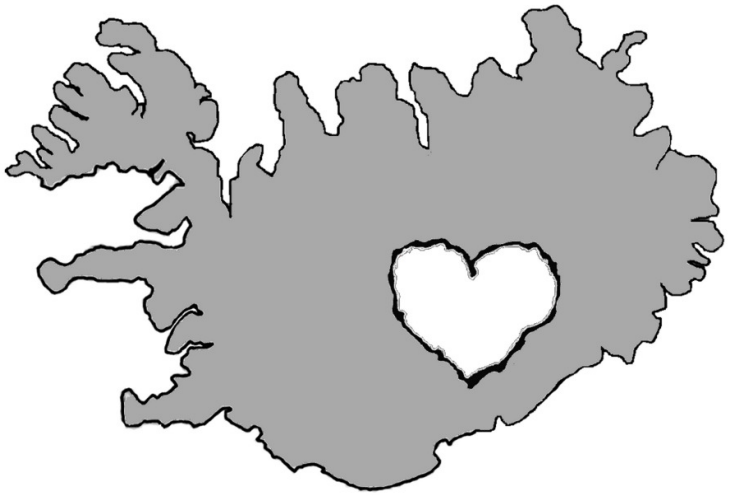
CHAPTER 8 | DISCUSSION



Main findings

The objective of this thesis was to investigate the validity of the Type D personality construct and its association with cardiovascular health across CAD patients and the general population in Iceland. The findings confirmed the validity of Type D personality in the Icelandic setting. Type D personality was associated with increased emotional distress and unhealthy lifestyle behaviors in both patients with CAD and individuals in the general population, and with a higher risk of developing CAD and a higher incidence of previous coronary events in the general population. Gender differences emerged in the association between Type D personality and treatment in patients with CAD, namely younger age of index-angiography and more re-angiographies in Type D women, and in some associations with risk factors for CAD in the general population. Finally, differences in coping styles were identified as psychological mediating mechanisms that may partly explain the association of Type D personality with increased emotional distress.

Validity of the Type D construct in the Icelandic setting

The verification of the construct validity of the Type D personality in both CAD patient and young healthy adult samples in Iceland (*Chapter 2 and 6*), supports the cross-cultural validity of the Type D construct and corroborates validation studies from other countries[1-4]. The Icelandic DS14 scale had comparable psychometric properties to the original version[5], and the NA and SI subcomponents of Type D personality were clearly related to other established personality traits, such as neuroticism and extraversion of the Five-Factor Model of personality, corroborating previous findings[3,6]. The findings provided much needed evidence for the role of emotional inhibition within the SI subcomponent of Type D personality[7] in both coronary patients (*Chapter 2*) and healthy young adults (*Chapter 6*). The verification of the construct validity of the SI trait is of considerable importance, as inhibited emotions may have an adverse effect on CAD outcomes[8]. The robustness of this finding is limited though by the self-reported measure of emotional inhibition. Observations of behavior of socially inhibited individuals in social situations would provide stronger validity information on the manifestation of emotional inhibition within the SI trait[7].

The validity of the Type D construct was furthermore confirmed in young healthy adults in *Chapter 6*, where it was also linked with emotional distress and more use of psychopharmacological medications. Previous validation investigations of Type D personality have mainly focused on CAD populations (e.g.[2,4,9]), although with some notable exceptions (e.g. [1,3,10,11]). However, the steady increase in studies investigating how Type D personality relates to health outcomes in both the general population[12] and non-cardiovascular disease samples[13] calls for widespread validations of the construct in non-CAD populations. Of note, the prevalence of Type D personality of 40% in *Chapter 6* was high compared with the other chapters (24-29% in the patient groups (*Chapters 2-5*) and 22% in the general population sample (*Chapter 7*). Prevalence of Type D in previous non-clinical study samples has ranged from 13-39%[14], but relatively high prevalence rates (from 30-39%) have been noted in university based samples[3,15,16]. Cross-cultural investigations in patient populations have also indicated that prevalence rates of Type D may differ by countries, ranging from 19-44% in cardiac patients[17]. The higher prevalence rate in *Chapter 6*, and other university based studies, may be attributed to the predominance of relatively young, female university students in each sample. Generally, women have a stronger tendency to report symptoms of negative affect[18] potentially leading to higher scores on the NA subcomponent.

Association of Type D personality with cardiovascular health in patients with CAD

Overall, Type D personality was not overly associated with the clinical profile of patients with CAD. The construct was not associated with indicators of disease severity (*Chapter 2-4*) or revascularizations procedures (C*hapter 3*) in patients with an established CAD. This fits well with the assumption that the association of Type D personality with adverse CAD prognosis does not stem from worse disease severity, seeing that the construct predicts adverse events after adjustments for disease severity[19].

Furthermore, Type D personality was not overly associated with conventional risk factors for CAD in coronary patients. The association of Type D personality with adverse CAD outcomes is generally thought to be independent of conventional risk factors, such as hypertension, diabetes and high cholesterol[20]. For the most part, the findings of this thesis corroborate this assumption. However, some inconsistency remains because the

construct was consistently associated with numerous behavioral risk factors in patients with CAD, such as smoking (*Chapters 2-5*), psychopharmacological medication use (*Chapter 2 and 4*), diet (C*hapter 4*), and more weight-gain in overweight patients (*Chapter 4*). Few studies have examined specifically how Type D personality relates to behavioral risk factors in coronary patients, but some studies have noted more smoking in Type D patients[17, 21-22]. Unhealthy lifestyle behaviors constitute one of the main mechanisms thought to mediate the association of psychological factors with adverse prognosis in patients with CAD[23,24], and modification of negative health-behaviors is considered vital for improvements of cardiovascular health[25]. Perhaps studies that have linked Type D personality with adverse CAD prognosis independent of conventional risk factors have mostly controlled for biological risk factors, and thus overlooked taking certain behavioral risk factors into account.

Another potential mechanism behind the association of psychological factors with poor cardiovascular health is poor treatment adherence[26]. Indeed, Type D personality was associated with a lower prevalence of hypertension medication treatment in patients with CAD (C*hapter 3 and 4)*, although in *Chapter 3* this difference was only found in women. Previous investigations have linked Type D personality with poor medication adherence in patients with CAD in general[27,28]. Conversely, findings in *Chapter 2 and 4* indicated that Type D patients used more psychopharmacological medication.

When gender differences where considered in the clinical correlates of Type D personality with CAD in coronary patients, unexpected associations emerged with younger age of Type D women at index-angiography (*Chapter 3*). Type D women undergoing coronary angiography were on average six years younger and yet had similar disease severity and risk factors as non-Type D women, and underwent more re-angiographies than other patients. Overall, CAD develops around ten years later in women than in men[29,30], but our findings suggested that Type D women undergoing a coronary angiography are at the same age as men (*Chapter 3*). This suggests that Type D personality may predispose women for earlier development of CAD. Recent evidence has linked psychological factors, such as cynicism and suppressed anger[31], depression[32], and recurrent major depression[33], to progression of coronary artery calcification (CAC) in healthy women and/or women with preexisting CAC. Conversely, recent findings from

studies not stratified by gender have not found an association between psychological factors and progression of CAC[34]. Thus, psychological and emotional distress may constitute a particular vulnerability for an earlier progression of CAD in women specifically.

Finally, the Type D personality construct was strongly associated with increased emotional distress in patients with CAD, at both hospitalization for a coronary angiography (*Chapter 4*), and 14-17 months post angiography (*Chapter 5*), independent of disease severity (*Chapter 4)* and baseline levels of emotional distress (*Chapter 5*). This is in line with previous findings, confirming the presence of increased emotional distress in CAD patients with Type D personality[19]. More importantly, the findings in C*hapter 5* also identified potential mediators behind the association of Type D personality with long-term emotional distress, namely more use of emotional coping style. Previous studies have also indicated that maladaptive coping styles may partly mediate the association of Type D with emotional stress[35,36], but these studies were based on cross sectional data which makes them more susceptible for biased results[37]. Maladaptive coping may also play a role in the modification of unhealthy lifestyle behaviors, but the findings in *Chapter 4 and 5* indicated that Type D patients with CAD were less likely to quit smoking after a coronary angiography.

Association of Type D personality with cardiovascular health in the general population

Compared to the extensive research conducted on Type D personality in patients with established CAD[19], few studies have investigated how the construct relates to cardiovascular health in the general public. Exploration of the association of Type D personality with individual risk factors for CAD in the general Icelandic population showed that individuals with Type D personality maintained unhealthier lifestyle behaviors, such as smoking, less physical activity, and wider waist circumference (*Chapter 7*). This is in line with previous reports from German[14] and Dutch[38] community samples, and smaller studies in young healthy adults[15,16], where Type D personality has for instance been linked with less exercise and unhealthy diet practices. Notably, the American Heart Association has identified four behavioral risk factor (non-smoking, body mass index < 25, sufficient physical activity, and healthy diet), along with three biological risk factors, as crucial to

improve cardiovascular health in the community as a whole[25]. Overall, Type D personality was only slightly associated with biological risk factors in the general population (*Chapter 7*). Higher cholesterol and blood glucose levels have however been noted previously in Type D individuals with metabolic syndrome[39]. Finally, Type D personality was associated with a higher prevalence of hypertension diagnosis but lower hypertension treatment in men (*Chapter 7*). Notably, previous studies in heart failure patients have linked Type D personality with inadequate consultation behavior[40,41].

Importantly, when numerous risk factors (biological and behavioral) where considered together with the Icelandic risk calculator (*Chapter 7*), Type D personality was associated with a higher 10-year risk of developing CAD in the general population. This is the first evidence relating Type D personality with a higher estimated risk for CAD. Although the increased risk in Type D individuals (of 12%) may perhaps be considered relatively small, it does indicate that when the overall risk factor profile of individuals are considered as a whole, individuals with Type D personality have a relative disadvantage compared to their non-Type D counterparts. Comparable indications can be referred from studies linking Type D personality with the metabolic syndrome[38,39], that refers to a clustering of risk factors (such as elevated blood pressure, cholesterol and blood glucose) that have been associated with a greater risk of CAD development[39]. In fact, we noticed a trend towards a higher incidence of the metabolic syndrome in Type D patients (*Chapter 7)*. Not all studies have however found a relationship between Type D and metabolic syndrome[42].

The higher incidence of previous coronary events in the general population (*Chapter 7*), suggests that Type D personality might play a role in the initial development of CAD. Given the cross-sectional nature of the data, no causal-inferences can be made about this association, but two recent general population studies do provide corroborative evidence for this finding[43,44]. Longitudinal investigations would be needed to test Type D personality as a potential etiological risk factor for development of CAD in the general population, as to rule out the possibility of reversal-causality, where individuals with CAD develop symptoms of negative affect and distress due to their disease.

Clinical implications

The results presented in this thesis generate insight into possible treatment and intervention opportunities to improve cardiovascular health in individuals with Type D personality.

Importantly, the higher prevalence of unhealthy lifestyle behaviors in individuals with Type D personality constitutes a plausible mediating factor in both the association of Type D personality with adverse prognosis of CAD patients and the increased risk of developing CAD in the general population. The use of more maladaptive coping strategies in Type D patients also predisposes them for more emotional distress, and may limit their capability to modify unhealthy lifestyle behaviors, as is evident in their tendency to continue smoking after a coronary angiography. Knowledge of this vulnerability for unhealthy lifestyle behaviors and maladaptive coping in Type D individuals has considerable potential to be useful in the clinical setting. Screening for Type D personality in patients receiving treatment for CAD could potentially help stratify and identify a group of 20-25% of patients who are more likely to suffer emotional distress, have more difficulties with modification of unhealthy lifestyle behaviors, and who may have a greater need for rehabilitation. These patients might benefit from self-management training[45] or coping skills training[46] to enhance modification of unhealthy lifestyle behaviors, and stress management to help them manage their increased emotional distress[47].

Modification of unhealthy lifestyle behaviors might not only be important in patients with CAD, but also in the general population. There is considerable room for improvements in healthy lifestyle behaviors in the community, given the alarming increase in obesity and diabetes seen in many countries[25,48], and that may particularly apply for individuals with Type D personality. Improvement of behavioral risk factors in the Icelandic community has been shown to greatly decrease mortality rates due to CAD[49]. Hence, healthier lifestyle practices in Type D individuals in the general population could yield enhanced cardiovascular health in their midst.

Moreover, the lower prevalence of hypertension treatment in both Type D women (*Chapter 3*) and Type D patients with CAD (C*hapter 4*)*,* and the higher prevalence of

diagnosed hypertension and lower prevalence of hypertension treatment in Type D men in the general population (*Chapter 7*) imply that Type D individuals may be less likely to receive prescription for hypertension medication, or alternatively that they are less likely to adhere to prescribed treatment. Previous studies support both possibilities, as Type D has been associated lower medication adherence in patients with CAD[27] and inadequate consultation behavior in heart failure patients[40]. Under-treatment and low adherence to prescribed treatment constitute a major problem in management of CAD[48], and this may be especially so in Type D patients. Type D patients could benefit from longer follow-up and more frequent visits to their cardiologist or general physicians, or from more assistance from nursing staff to help them manage their treatment. The aforementioned self-management[45] and coping skills training[46] could also facilitate better disease management.

Finally, a closer look at the role of emotional distress on cardiovascular health in women seems warranted, as Type D personality might potentially contribute to an earlier progression of CAD in women. Given the younger age at index-angiography and higher prevalence of re-angiographies in Type D women, cardiologist and angiography lab staff should perhaps consider whether increased emotional distress affects symptoms, clinical assessment, and treatment decisions of women with CAD.

Limitations and methodological considerations

Several considerations need to be taken into account in the interpretation of the current findings. This thesis is based on various participant samples, ranging from healthy, young adults, to the general population and patients who have an established CAD. Most of these participant samples were collected by suitable means, with random sampling from the general populations (*Chapter 7*), or recruitment of patients undergoing a certain medical procedure or receiving clinical care at a specific ward (C*hapters 2-5*). Accordingly, selection bias is not likely to be an influential factor on results in those chapters. This may not apply though to the follow-up findings in *Chapter 4 and 5*, where not all participants completed follow-up. Participant recruitment in *Chapter 6* was conducted via convenience means among university students, and may thus not represent sufficiently well healthy young adults from the Icelandic general population.

Importantly, the cross-sectional nature of the majority of the studies reported in this thesis (all except *Chapters 5* and a part of *Chapter 4*) prevent any causal-inferences regarding their findings. Hence, it remains to be examined longitudinally whether Type D personality predicts incidence of first CAD-related events in the general population (that is, in individuals free of CAD at baseline). This pertains also to the link between Type D personality and emotional distress in *Chapter 4*, but that limitation is counterbalanced by the longitudinal design of C*hapter 5*, which is partially based on the same sample and does provide causal evidence for the association. Of note, the participants in *Chapter 7* will be followed for 5-10 years, which will create opportunities to test Type D as an aetiological risk factor for CAD onset in the general Icelandic population.

Equally important, it remains to be determined whether Type D personality is associated with adverse prognosis due to CAD in the Icelandic setting. Data regarding mortality due to CAD-related events (i.e. heart attacks) in patients with CAD were not yet available, but will become available in upcoming years.

Another main methodological limitation in the overall thesis is the use of self-report data for numerous variables. This applies specifically for the information regarding incidence of previous coronary events in the general population in *Chapter 7*, which was not based on clinical data. Here, there is a possibility of recollection bias, and reliability of the information could be increased by collecting data from the national health registry, hospital records and/or general practitioner files. Measurements of numerous risk factors for CAD were also based on self-report (for instance physical activity (C*hapter* 7) and smoking (C*hapter 2-5 and 7*)). A few measurements were not based on the risk factor themselves, but on whether patients or individuals were being treated for that risk factor (e.g. treatment for hypertension in C*hapters 3, 4 and 7*). These measurements may provide information on differences in treatment of risk factors, utilization of medical assistance, and adherence to treatment of risk factors instead of the risk factors themselves.

Future research directions

The current findings suggest that identification of Type D personality in the clinical setting can help identify patients with CAD who maintain various unhealthier lifestyle behaviors, use more maladaptive coping, may have worse medication adherence, and experience

more emotional distress. Similar associations were noted in the general populations. As modification of behavioral risk factors for CAD is highly important in the prevention of further CAD related events, further investigations should examine more thoroughly how Type D personality is related to behavioral risk factors of CAD. Such investigations might ascertain if Type D patients need specific interventions in secondary prevention to help them modify their unhealthy lifestyle behaviors, and designate to what extent behavioral risk factors explain the association between Type D personality and poor cardiovascular health.

Furthermore, although Type D personality was associated with an overall increased risk of developing CAD and more previous coronary events in the general population, the current thesis findings did not reveal whether Type D personality was in fact associated with increased mortality rates in the Icelandic setting. Future research projects need to ascertain whether Type D personality is associated with increased mortality rates in patients with CAD, and incidence of CAD-related events in the general population with longitudinal study designs.

Conclusion

Substantial evidence has accumulated in recent years linking Type D personality with poor prognosis in patients with CAD[19,51], but the majority of this evidence has been based on participant samples from the Netherlands and Belgium[52]. The findings of the current thesis provide much evidence regarding how the Type D personality construct is related to cardiovascular health in a geographically different sample. They also present new evidence linking the construct with risk of initial development of CAD, provide information regarding potential pathways behind the association of Type D personality with adverse cardiovascular health, and give insight about possible interventions for individuals with Type D personality. Overall, the findings reported in this thesis support the importance of further prospective research on the predictive importance of the Type D construct in both patient and general population samples in Iceland.

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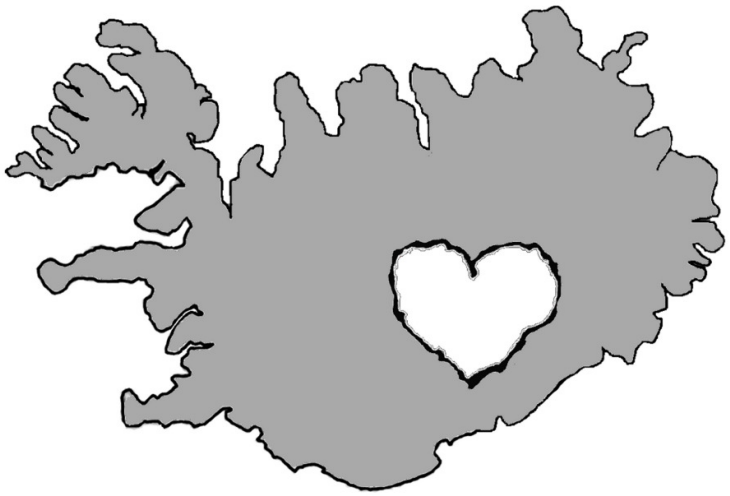
CHAPTER 9 | ENGLISH SUMMARY



Coronary Artery Disease (CAD) is a major cause for mortality worldwide. An important part of the fight against CAD is prevention, namely predicting people's risk of developing CAD, and helping reduce that risk through management of risk factors for CAD, such as hypertension, smoking, physical inactivity and unhealthy diet. Psychological factors can promote the development and clinical manifestation of CAD as well. The importance of psychological factors is increased further still because they can act as barriers for treatment adherence in patients with CAD and effective modification of lifestyle-related risk factors. One psychological factor that has reached some credential as a valid risk factor for prognosis in patients with CAD is the distressed (Type D) personality.

Type D personality consists of two personality traits, negative affectivity (NA) and social inhibition (SI), and portrays individuals who experience frequent negative emotions across time and situations (NA), but tend to inhibit their emotions in social situations (SI). The combination of these two traits within the Type D construct has been related to worse prognosis in cardiac patients, including increased morbidity and mortality and long-term psychological distress. The mediating pathways linking Type D personality with adverse cardiac prognosis are generally thought to reside in both biological and behavioral mechanisms. Initial evidence regarding the mechanisms linking Type D personality with psychological distress, has suggested that maladaptive coping may play a part in that association.

The previous research literature of Type D personality is, however, limited in the sense that the majority of studies have been conducted in Dutch or Belgian patient samples, while for instance a recent German study has not found an association between Type D personality and poor prognosis in cardiac patients. Thus, more geographically diverse studies on the construct are needed. In addition, little is known about Type D personality as an aetiological risk factor for the onset of CAD. Thus, the aim of this thesis was to (1) assess the validity of the Type D personality construct and its association with poor cardiovascular health in Icelandic patients with established CAD, (2) to explore how Type D personality is related to cardiovascular health in the general Icelandic population.

OVERVIEW OF CHAPTERS AND FINDINGS

The first part of this thesis focused on the validity of the Type D construct and its association with cardiovascular health in coronary patients in Iceland. In *Chapter 2* the construct validity of Type D personality was confirmed. The psychometric evaluations of the Icelandic Type D scale (DS14) confirmed the two-factor structure of the scale and the convergent and divergent validity of NA and SI. Assessment of Type D personality was not confounded by disease severity, but Type D patients reported more use of psychopharmacological medication use and more smoking.

Chapter 3 reported on the association of Type D personality with the clinical profile of Icelandic patients undergoing coronary angiography, and gender-related differences in these associations. Type D personality was associated with more smoking, but not with other conventional risk factors, disease severity or treatment. In a gender stratified analysis, Type D was associated with a younger age at index angiography, less medically treated hypertension and more re-angiographies in women, but not in men.

Chapter 4 examined the relationship between Type D personality and anxiety, depression and stress in cardiac patients at hospitalization, assessed if this relationship is independent of disease severity, and explored whether Type D patients maintained fewer health-related behaviors four months post angiography. Type D personality was associated with increased psychological distress, independent of demographics and disease severity. At follow-up, Type D patients reported less fish consumption, and a higher prevalence of smoking and use of sleep- and antidepressant medication use.

Chapter 5 reported on the relationship of Type D personality with anxiety, depression and stress in cardiac patients 14-17 months post angiography, examined the mediating role of coping style in this relationship, and explored differences in smoking cessation by Type D personality. Type D personality was associated with increased psychological distress and more emotional coping at follow-up. In mediation analyses, emotional coping had a significant indirect effect in the association of Type D personality with psychological distress measures, indicative of partial mediation. Finally Type D patients were more likely to continue smoking during follow-up. Of note, Type D patients who smoked at follow-up reported more psychological distress, compared to Type D patients who did not smoke at follow-up.

The second part of this thesis tested the validity of the Type D construct and its association with cardiovascular health in the general Icelandic population. In *Chapter 6* the validity of the Type D construct was confirmed in a sample of healthy young adults. The Type D personality subcomponents were associated with the Five-Factor Model of personality and emotional control, and SI was closely related to emotional inhibition. Furthermore, Type D personality was associated with higher levels of anxiety, depression and stress, more use of psychopharmacological medications, and a higher prevalence of previous mental health problems.

Chapter 7, conversely, focused on the relationship between Type D personality with risk factors for CAD, estimated risk of developing CAD, and previous cardiac events in individuals from the general population. In this chapter, Type D personality was associated with some conventional risk factors for CAD, and various lifestyle-related risk factors (e.g. waist circumference, lack of physical exercise, and smoking), but gender differences were noted in some of these associations. Furthermore, Type D personality was associated with a higher estimated 10-year risk of developing CAD, independent of other risk factors, and a marked increase in the incidence of previous cardiac events.

GENERAL CONCLUSIONS

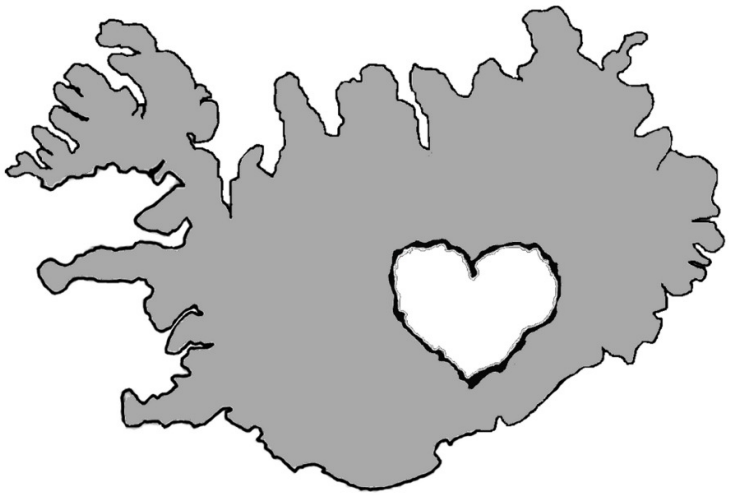
The overall findings of this thesis confirmed the validity of Type D personality in the Icelandic setting, and supported its cross-cultural validity. Type D personality was associated with increased psychological distress, various lifestyle-related risk factors, and health-related risk markers in both coronary patients and individuals in the general population. Moreover, Type D personality was associated with a higher estimated risk of developing CAD and a marked increase in previous coronary events in the general population. Gender differences also emerged in the association between Type D personality with younger age of index-angiography and more re-angiographies in women, suggesting that Type D personality may predispose women for earlier progression of CAD. Finally, differences in coping were identified as potential mediating mechanisms that may partly explain the association of Type D personality with psychological distress. Maladaptive coping may also affect unhealthy lifestyle modification in Type D patients.

The overall findings of this thesis provide information regarding potential pathways behind the association of Type D personality with adverse cardiovascular health and give insight about possible interventions for patients with Type D personality. Identification of Type D personality in the clinical setting might help identify patients with CAD who maintain various unhealthier lifestyle behaviors, use more maladaptive coping, and experience more emotional distress. As modification of behavioral risk factors for CAD is highly important in the prevention of CAD-related events, further investigations should examine more thoroughly how Type D personality is related to behavioral risk factors of CAD. Such investigations might designate to what extent behavioral risk factors explain the association between Type D personality and poor cardiovascular health, and ascertain if Type D patients need specific interventions to help them modify unhealthy lifestyle behaviors. Furthermore, a closer look at the role of emotional distress on cardiovascular health in women seems warranted, given the large age difference in Type D women undergoing coronary angiography.

Modification of unhealthy lifestyle behaviors might also be important for Type D individuals in the general population, but improvement of behavioral risk factors in the Icelandic community have been shown to greatly decrease mortality rates due to CAD. Importantly, the findings present new evidence linking Type D personality with risk of initial development of CAD, but longitudinal investigations are needed to test Type D personality as a potential etiological risk factor for development of CAD.

To conclude, the findings of the this thesis support the importance of further prospective research on the predictive importance of Type D personality in both patient and general population samples in Iceland.

CHAPTER 10 | BIBLOGRAPHY AND CURRICULUM VITAE



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Svansdottir E, van den Broek KC, Thorsson B, Gudnason T, Halldorsdottir S, Gudnason V, Denollet J, Karlsson HD. Association of Type D personality with unhealthy lifestyle, and estimated risk of coronary events in the general Icelandic population. *Eur J Cardiovasc Prev Rehabil* 2012, (in press).

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SUBMITTED

Svansdottir E, van den Broek KC, Denollet J, Gudnason T, Karlsson HD. Type D personality and gender-related differences in the clinical profile of patients with coronary artery disease. Submitted.

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Svansdottir E, van den Broek KC, Karlsson HD, Olason TD, Thorgilsson H, Denollet J. The Distressed (Type D) and Five-Factor Models of personality in young healthy adults and their association with emotional inhibition and distress. Submitted.

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Erla Svansdóttir was born in Reykjavik, Iceland, on the 5th of December 1979. She completed her pre-university education at Menntaskólinn í Kópavogi in 2001. In 2002, she started studying psychology at the University of Iceland, and completed a Bachelor's degree (BA) in psychology in 2004, and a cand.psych degree in 2006. Subsequently, she developed her cand.psych thesis into a full-scale PhD research project in collaboration with Landspitali-University Hospital, the Icelandic Heart Association, and Tilburg University. She has published scientific papers in the Journal of Behavioral Medicine, BMC Public Health, and European Journal of Preventive Cardiology, and presented her scientific work at international congresses in San-Antonio (Texas), Geneva, Reykjavik, and in the Netherlands.